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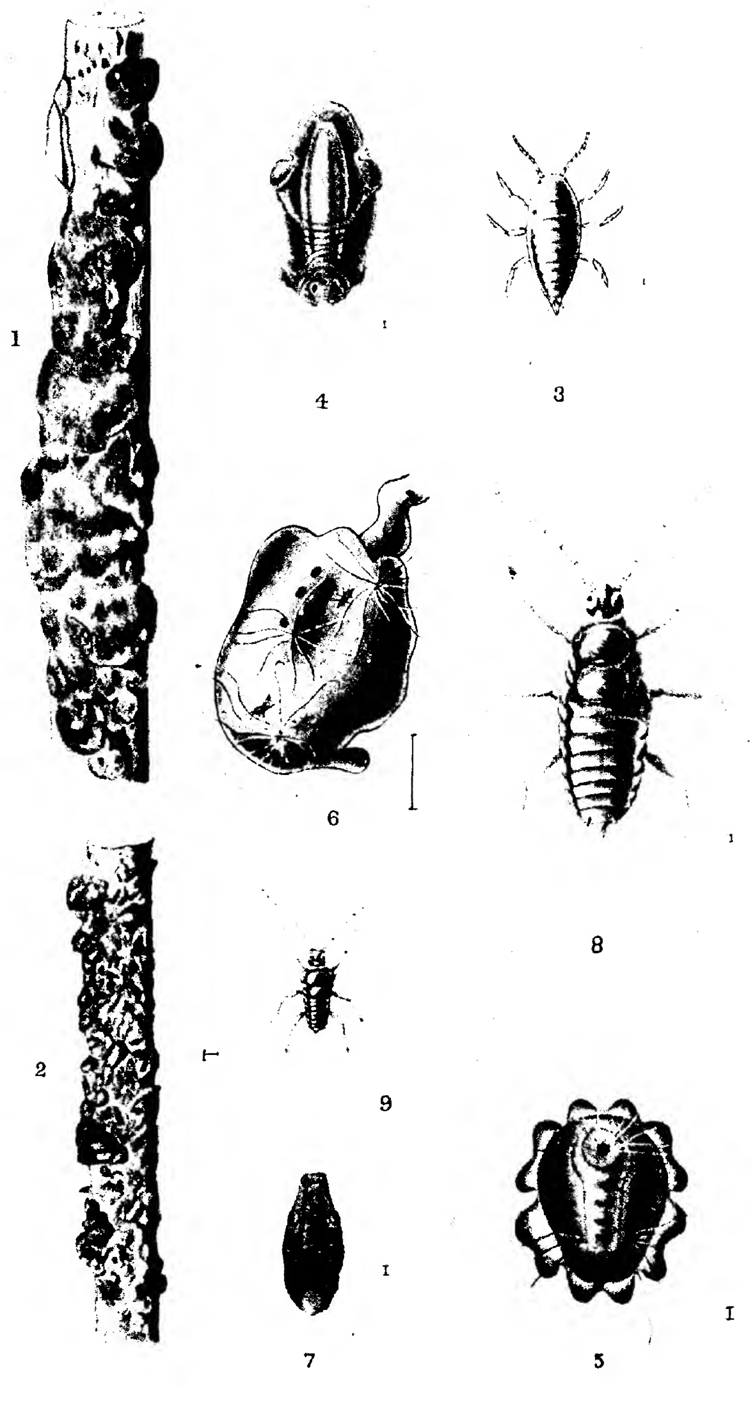

TACHARDIA LACCA

PLATE XXIV.—Tachardia Lacca

Lac.

Fig. 1. Healthy insects on stick.
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THE FURLOUGH WANDERINGS OF A DIRECTOR OF AGRICULTURE.*

BY J. MACKENNA, M.A., I.C.S.,

Director of Agriculture, Burma.

II. CAMBRIDGE.

IN my first article I dealt with the only place in Great Britain, with which I am acquainted, where the work is limited, strictly to research—untrammelled and unfettered by the superimposition of teaching. That this is the ideal situation, there can be no doubt; but financial considerations render it quite impossible in most cases to tell off one section for research and another for instruction. In most places in Great Britain, as in India, one man has to perform both functions—that of a Research Officer and that of a teacher. In Germany this is not so; but there seems to be in Germany not only more money but more men for scientific investigation and instruction.

Of those institutions visited by me which combine the two classes of work, pride of place must be given to the oldest established University, which has interested itself in agricultural science. With the rapid expansion of interest in agricultural science it was only to be expected that the ancient University of Cambridge, which has always been in the forefront of scientific progress, should put its house in order in this respect, and so, although it is a matter of comparatively recent growth, we now find at Cambridge a fully equipped Agricultural Department.

It is but fitting that the English University which, more than any other, has been the home of science, should thus encourage the most practical of all the sciences and that which so much depends on a knowledge of all the natural sciences.

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* Continued from Vol. IV, Part I, p. 15.

The visitor to Cambridge who asks for the "College of Agriculture" will probably never find it. There are no massive piles with domes and canopies to mark the home of agricultural science. They are very modest in Cambridge. I traversed numerous dark and subterranean passages at the University Chemical Laboratories to find myself in Professor T. H. Middleton's room—a dim and dismal sanctuary—with his colleague and successor—T. B. Wood's—hard by. Where R. H. Biffen the Botanist laboured, I never discovered, and the only regret of my visit to this ancient seat of learning was that I did not meet with this distinguished botanist whose Mendelian work on wheats is so well known. The *personnel* has changed since I was there. Professor Middleton has gone to the Board of Agriculture and has been succeeded by Professor T. B. Wood. The lecturer on agriculture is the portly and genial Mackenzie of Wye.

As I have remarked above, the agricultural work at Cambridge, as at most other Universities or Colleges in Great Britain, divides into two sections: teaching and experimental research. As a very large number of young Indian students now find their way to England to pursue their scientific studies, it may be of interest to outline the courses of instruction given at Cambridge.

The student of agricultural science at Cambridge can either obtain the degree of Bachelor of Arts or the University Diploma in agriculture. In the former case a residence of three years is required and the student must pass the previous examination in general knowledge. This may be taken and, generally, is passed before entering the University. It is then open to him to take either a general examination in literature, mathematics and science, or Part I of one of the regular Tripos examinations. If he is wise, he will take the latter course; and if he is well advised, he will select the Natural Science Tripos. In point of fact, this is the advice generally given by College tutors, who wisely insist on a general scientific training before the study of agriculture, pure and simple, is begun. The third stage is the special examination in agricultural science which

counts both for the degree of Bachelor of Arts and as Part I of the examination for the Diploma in Agricultural Science and Practice. Having obtained his degree of Bachelor of Arts, the candidate who has taken Part I of the examination in Agricultural science can proceed to take Part II of the special examination, and so qualify for the University diploma in Agricultural Science and Practice. In point of fact, for a student who proposes to take the degree of Bachelor of Arts, the courses can be made to overlap, so that one set of studies leads up to both qualifications. For a candidate, however, who merely wishes to take the Diploma in Agricultural Science and Practice no restrictions as to residence or other examinations are required. He has simply to pass Parts I and II of the special examination in Agricultural Science. The course is a two years' one; but if a student has taken Part I of the Natural Science Tripos with Botany, Chemistry and Geology as subjects, he can take the additional classes necessary for the Diploma in one year.

The Board of Agricultural Studies lay great stress on the importance of taking at least Part I of the Natural Science Tripos and strongly recommend students who aspire to appointments to take Part II also, which gives them the degree of Bachelor of Arts. This advice is, I think, absolutely sound. The better the general scientific training (I would almost add literary training also), on which agricultural science is based, the more accurate and wider will be the outlook of the student who has enjoyed these advantages.

Students reading for the Diploma in Agriculture may either join the University or not as they prefer. In the former case they will, in all likelihood, attach themselves to a particular College and, if they reside in College, they will enjoy those social and other advantages which residence in a College is supposed to confer. If, however, they elect to be non-collegiate or not to join the University, they will live in lodgings in the town and make their own arrangements. The latter is certainly the cheaper course; but for students from India the experience which College-life must give, is well worth the extra expense involved.

I have dwelt on the educational side of Cambridge at some length, because the subject is likely to prove of interest to Indian youths who are contemplating a course of study in England. I would strongly recommend such to take the Natural Science Tripos as well as the Diploma, and, if they can possibly afford it, to live in College. It is not only by its lecture rooms that an University educates. There are lessons learnt which do not form the subject of examination papers; but all of which go to the formation of character and to the equipment necessary for the battle of life. The East has much to teach the West as the West has much to teach the East, and I can imagine no better experience for all concerned than the interchange of views between English and Indian students engaged on the same studies which must result from in-College life.

The second aspect of the work at Cambridge is experimental research; and, although the School of Agriculture is a thing of very recent growth, a great amount of first class work has already been done. A very marked feature of this experimental work is the close contact which the Department of Agriculture already has with land-owners and tenant farmers. Thus, while the main field research work of the Department is done at Burgoyne's (University) Farm at Impington, a large number of useful experiments are also conducted under the supervision of the Department at various centres in the Eastern Counties on land placed at the disposal of the department by private farmers. These are, practically, small demonstration plots; but, whereas in India, Government generally must equip and maintain these, the position of Agriculture in Great Britain is such that enlightened farmers will willingly lend their land and share in the conduct of experiments. This is a system which we should soon be able to apply in India, and I have no fears of being able to obtain an equally willing response from the Indian farmer.

It is a pleasant walk of some five miles from Cambridge to Burgoyne's (University) Farm at Impington, and there I was met by Professor Middleton, who had come out by train. He explained that the farm was leased; the necessary capital to

work and equip the farm being raised by subscription. The conditions of lease are peculiar. The farm was in very poor condition when entered on by the Department. It is let on the understanding that no rent shall be paid for the first nine years, but that the land shall be brought into good condition. There are some minor conditions attached to the lease, and the Department has the option of leasing the farm, on a rental, for 10 years after the expiry of the present lease.

The area of the farm is about 140 acres. The soil is light to medium; burns quickly in dry weather and becomes very sticky—like so many of our Indian soils—after rain.

From a scientific point of view the most important piece of work being done at the farm is Biffen's work on wheat and barley. Unfortunately we had not the advantage of an explanation of the work by Biffen himself, but a very full account is given in his paper "Mendel's Laws of Inheritance and Wheat-breeding" in the *Journal of Agricultural Science* (Volume I, Part I), for January 1905. The main problem which he is attacking, is to obtain a "strong" English wheat, which will satisfy the English miller. In the article referred to, he remarks that the necessity of such work may not be evident to all. "The fact," he writes, "is generally recognised that the wheats of this country are characterised by the high yields per acre and by the shapeliness of their grain. We can grow on the average over 30 bushels to the acre, where the United States grew 14, Russia 10, and the Argentine 7. Yet the acreage under wheat in this country has fallen from three-and-a-half million acres in 1876 to one and-a-half million in 1903, and we now grow approximately only one-fifth of the wheat we consume. Further than this, there is good evidence to show that the quality of the grain now grown is inferior to that of 20 years ago. It has been sacrificed to yield and many of the better class varieties...........have been more or less driven out of the field by varieties...........which are capable of giving slightly larger crops of grain and straw. These inferior varieties have now to compete with wheat imported from Canada, the United States, Russia and other countries.

The seriousness of the position becomes evident when one finds English wheat selling at 28*s.* 6*d.* a quarter when Manitoba Hard is selling at 33.

On searching for the reasons of this, the miller tells us that English wheat even of the better class varieties is lacking in "strength." We have no single variety which can be compared in this respect with the best foreign wheats. By "strength" he means the capacity of the wheat to produce a large, well piled loaf. We learn also that English wheat to be utilised at all for bread-making purposes has to be mixed with a large percentage of these strong foreign wheats. The flour of English-grown wheat alone will not produce a loaf which is marketable under present conditions, and until the public taste demands dull and heavy bread, such wheat can only be used in "mixtures."

Biffen also points out a further complication. With the expansion of colonial export of wheat, flour mills have sprung up at the seaports where the hard grain obtained from the colonies is at once milled. Inland millers who require this hard grain to mix with the English wheat are handicapped by the extra cost of transport from the seaport to the inland town. "If, in order to compete with the port miller, he has to use still larger quantities of foreign grain to make up for the shortcomings of our own, their prices must fall still lower, or he will be driven out of the field, and with him will disappear the market for home-grown wheat. The whole question then pivots on the strength of the grain we can produce. Even a slight increase in quality would go a long way to improving the position both from the farmer's and miller's point of view, for it would immediately widen the market for the home product."

Such is the very definite and important economic problem which the Botanical Section at Cambridge have placed before themselves. The aim of the experiments is to discover a "hard" grain and the system followed is that of "cross-breeding" acting on the principles of Mendel's Law of Inheritance.

The experiments, which are conducted under a wire net house, commenced with the growing of some 200 different

varieties of wheat. Of these a large number were discarded after the first year, as having no marked characteristics or as being unsuitable to English conditions. Those with marked characteristics, for example, resistance to rust, good straw, heavy yield, were retained and crossed with wheats proved to be of a good milling quality. When I visited Impington, four generations of wheat hybrids were being grown. As soon as type characteristics are fixed, those hybrids which show a distinct superiority over English wheat are grown; and by a process of rigorous selection and rejection it is hoped that a "strong" wheat will ultimately be obtained which will meet the requirements of the English miller. The theory once proved, it is only a matter of the production of the seed in sufficient quantities to affect the whole crop of the country. There is any amount of work of this kind to be done in India and the Botanists of the Agricultural Service have a great field before them.

With barley and other cereals, the process is not yet so elaborate. The experiments are really purely varietal: that is to say, all available varieties are grown for comparative study and only the best are retained: the outturn and weight of the grain and the weight of the straw being all taken into account.

In this varietal work the assistance of private farmers has already been enlisted; the comparison, in such cases, being between the selected variety issued by the Department of Agriculture and the varieties generally cultivated by the gentlemen conducting the experiment. This is quite the most certain way of ensuring the adoption of a better variety on the farm where the experiment has been conducted.

While the work on the "cross-breeding" of wheat is, undoubtedly, the most important being done at Cambridge, there is a very thorough piece of work being carried out on the principal root crops which is full of interest, principally on account of the accuracy of the methods adopted; and the close inter-relation of the field and laboratory work. The root crops worked with are Swedes, Mangels, Turnips and Kohl Rabi. The first stage of the experiment is the growing of the varieties for comparison of yield

per acre. But in the case of root crops bulk is not everything. The food content of a root or its food value is an equally important factor; one may have a very large root which contains an enormous quantity of water and which will not have the food value of a much smaller root containing a larger quantity of dry matter. Accordingly a large number of roots are subjected to analysis in the chemical laboratory and, from a consideration of yield and food content taken together, the most profitable varieties can be selected. From these selected varieties seed for further trial is obtained, the ultimate object of the experiment being the obtaining by selection of improved varieties of roots. As bearing on this subject I would invite attention to a valuable paper on "Variation in the Chemical Composition of Mangels" by T. B. Wood and R. A. Bery, which will be found at page 176, Volume I, Part II of the *Journal of Agricultural Science*.

The mangel crop is the most important root crop of the Eastern Counties around Cambridge, and the Department of Agriculture has, therefore, devoted much attention to this crop. Experiments are varietal—to test the composition and yield of the different varieties on the market. Incidentally, as these experiments are carried on at private farms as well as on the University Farm, the variations due to change of locality can be noted. This is an important point which is probably not sufficiently taken into account. It has been particularly noted in the case of oats transferred from Scotland to the South of England.

Another valuable series of experiments is designed to show the effects of manures on the yield and composition of mangels, while a similar series is applied to the swede crop. The general conclusion would seem to be that manures have but little effect on the composition of mangels.

A point of considerable scientific interest to which my attention was drawn, was the effect of the size of a root on its composition. It has been found in the case of long red mangels, that as the size increases from 2 to 3 lbs., the dry matter decreases

·7 per cent.; from 3 to 4 lbs. ·6 per cent.; from 4 to 5 lbs. ·4 per cent.; from 5 to 6 lbs. ·3 per cent.; and from 6 to 7 lbs. ·2 per cent. Similar enquiries on the root crops of India would be interesting.

A large amount of work has also been done on the potato crop, and some of the results are highly interesting. In the varietal tests for yield which extended over a series of years the best results were obtained in the first year, 1902, from "Dobbie's Factor," obtained from Scotland. In the second year, 1903, the produce of the 1902 crop was again planted. "Dobbie's Factor" still held the lead amongst the old stock with a total outturn of 12 tons 12 cwt. and 14 tons 8 cwt., but was eclipsed by a new strain introduced for the first time—"Findlay's Evergood" from Lincolnshire—which yielded 13 tons 19 cwt. and 14 tons 16 cwt. New seed of "Dobbie's Factor" was also obtained this year, some from Lincolnshire and some from Scotland. These came second and third with outturns of 11 tons 17 cwt. and 12 tons 19 cwt. in the case of the seed from Lincolnshire and 11 tons 9 cwt. and 12 tons 16 cwt. in the case of the seed from Scotland. When seed from the original crop of 1902 was planted for the third time in 1904, it was found that Findlay's "British Queen" which had been fifth on the list in 1902, with a yield of 6 tons 9 cwt., now headed the list with an outturn of 12 tons 6 cwt., while "Dobbie's Factor" had fallen into the second place with 11 tons 2 cwt. In the case of seed taken from the 1903 crop and planted for the second time in 1904 there was a general improvement in outturn, which may, to an extent, have been due to the varying conditions of the season.

In addition to varietal tests the effects of cutting "sets": a comparison between large and small "sets": "sets" stored in pits and "sets" stored in potato boxes; and the usual manurial experiments indicate the lines of work being done on this crop.

The rotation experiment at Burgoyne's Farm had not reached a stage, when I visited Cambridge, at which any definite conclusions could be drawn. The object of the experiment is "to ascertain at what time it is best to apply phosphates and potash

to crops grown in a four-course rotation. Manures containing phosphates and potash are applied chiefly to assist roots and clover. The main question here is: Do such manures when applied to the root crop satisfy the requirements of the following clover crop?"

A considerable area of the farm has been laid down to permanent pasture, which is divided into sections to permit of the comparison of various systems of manurial treatment. No definite results had been obtained at the time of my visit.

I had not an opportunity of seeing the work done on private farms, or on the Experimental Farms of the East Suffolk County Council, which are controlled by the University Department. As I have said above, the close relationship which exists between the Department and the private farmer is one of the principal and most gratifying features of the Cambridge work: while all their experiments suggest the scientific atmosphere which seems inseparable from Cambridge.

A most enjoyable day ended in the Senior Common Room of St. John's College where, in the mellowed light of antique silver candlesticks one discussed old Indian experiences with Professor Middleton, whose recollections of his seven years in Banda are still fresh; talked of Burma and the Burmans to Dr. Scott—then Bursar and now Master of the College, whose interest in Burma is a fraternal one; and discussed various geological problems with the veteran, Dr. Bonney, till such time as "gates closed" loomed near, and we set forth for our respective abodes lest, peradventure, the Proctor should catch us unawares.

(To be continued.)

THE ADVANTAGES OF IRRIGATION WHEN THE SUPPLY AVAILABLE IS USED FOR RABI OR COLD WEATHER IRRIGATION.

By ARTHUR HILL, C.I.E., F.C.H., M.INST.C.E.,

Chief Engineer for Irrigation, Bombay.

In a country, where there is no rain, the advantages of irrigation are clear to everyone, for no crops can be grown without irrigation, all crops are entirely dependent upon the water from the canals, and require water at regular and suitable intervals for their proper growth ; but in countries where the rainfall is scanty and precarious, irrigation is even of greater value and more far-reaching in its effects, for the water is needed to supplement the supply obtained from the rainfall, the canals have not to provide the whole of the water for the growth of the crops, and the volume available can bring a far larger area of crop to maturity than when the entire water supply for the crops has to be provided.

The greater part of Central India, and in particular the Deccan, consists of tracts where the benefits to be derived from irrigation are immense. The fields are in ordinary course cultivated and prepared for the growth of crops if the natural rainfall comes, but the arrival of the rain is uncertain, and until the ground has been sufficiently welted to provide moisture for the germination of seed, many cultivators of scanty means, to whom the loss of the seed is a serious matter, refrain from sowing their fields. When the rain does fall in sufficient quantities and the sowing of seed would no longer be a risk, it often happens that the rain is heavy and continuous, rendering the surface of the ground unfit for sowing operations, and cultivators are unable to get into the ground the seed of crops they intend to grow ; as the

rainy season is of limited duration, the time for the growth of the crops is materially shortened, and may easily become insufficient and poor crops result. Now, when a supply of water is available from a canal for irrigation, the time of sowing is no longer fixed by the precarious rainfall, but the cultivators may choose the time they deem most suitable from their long experience, can obtain water from the canal to prepare their field for sowing and can get the seed into the ground at the best time of year. Again, if rain falls, at the beginning of the season, only just sufficient in quantity for the production of a surface on the fields suitable for sowing, the cultivators may get their seed in at once without anxiety as to the result, for if further rain does not come as required, water can be obtained from the canals to ensure the growth of the crop. In the matter of sowing at a suitable period of the year, the presence of a canal, with a reliable water-supply, has an effect on the cultivation and prosperity of a district far in excess of the actual irrigating capacity of the canal. It may happen in some years that the canal is not required to irrigate the monsoon crops at all, but that the prompt sowing has enabled the cultivators to obtain far better crops than their neighbours, who have to work without the resources of a canal to fall back on.

It is, however, in supplementing the rainfall that the canals give the greatest benefit to the land commanded. The rainfall is frequently, and in the Deccan districts, usually, either insufficient, or falls at intervals too far apart for the proper growth of the crop ; the report "crops withering" is one only too familiar to District Officers in India, and at such periods crops can be saved by one or two waterings. The actual amount of water required to mature a cereal crop is not great ; careful experiments in India have shown that a total depth of 12 inches to 14 inches delivered on to the field, by waterings at suitable intervals, is sufficient to mature a cereal crop ; and in the Eastern counties of England where excellent crops of cereals are grown, the total average for the whole 12 months is 25 inches only ; and in years when the rainfall is considerably below the average, excellent crops are

obtained, and yet much of the rain does not fall whilst the crop is in the ground. Tracts of similar rainfall in India produce excellent cereal crops; for instance, the rainfall in the Eastern Deccan where jowari or great millet is grown as a *rabi* crop is frequently under 18 inches for the period of growth of the crop, but if suitably distributed is sufficient.

If, therefore, some 8 inches of rain have fallen and crops have started well, then a single watering from a canal followed later by a slight rainfall, or by a second watering, is sufficient to produce excellent cereal crops.

In actual practice in India these conditions occur frequently in the middle of the monsoon or summer crop, and at the end of the *rabi* or cold weather crop.

Fields are sown after the early burst of the monsoon and then a long break comes during which a watering is required, or the crops would wither, and then the autumn rains come and provide the moisture for the last stage of growth of the crop. The quality of the monsoon crop may be deteriorated by excessive autumn rain, but there will always be a crop and abundance of good fodder if helped by a canal.

It is for the cold weather or *rabi* crop, however, that irrigation is most appreciated and desired. Sufficient rain as a rule falls for the sowing, but the subsequent rains required to mature the crop are most precarious, and frequently fail. The quantity of rain required is not large, as at this season of the year dews are usually heavy, but if the rain does not fall, then the crop fails, or is seriously deficient. The difference in the outturn of a cereal crop that one watering can make when the *rabi* crops have started well, but are withering for want of more rain, often means three-quarters of the crop. These *rabi* crops are not liable to damage during harvest; at the end of the *rabi* season rains cease and the harvesting is, as a rule, uninterrupted by the weather. The *rabi* crop is thus the one for which irrigation is most desired, and for which it is most wanted.

Now, away from the rivers fed by the melting of snow on the hills there are few streams in India where any large volume

of water can be obtained during the *rabi*, or cold weather season, and, on the streams without snow-hills at their source, in order to ensure provision of water for *rabi* crops, it is usually necessary to store the water in tanks or reservoirs. Storage of water is always expensive, and the supply available and the capacity of the reservoir are, as a rule, less than required by the land to be irrigated, and the proper use of the stored water requires very careful consideration. In India with its wealth of sunshine, and freedom from frosts, most valuable crops can be grown if water is available the whole year round. Sugar-cane is one of the favourite crops for perennial irrigation, and the very high returns to be obtained from this and other twelve-months crops bring prosperity to the fortunate individuals who can obtain the water, and they are ready to pay apparently high prices for the perennial water, and to pay them regularly.

This regularity of demand and payment is a most important consideration in the working of a canal, and to the casual observer it appears much the best plan to encourage this valuable perennial irrigation, and to reserve the stored water specially for it; but though this brings great profit to a few, it grievously curtails the prosperity of the land as a whole under the canal, and seriously diminishes the money returns which can be obtained for the water.

When valuable perennial irrigation is undertaken under a canal, and the cultivators have not wells, or not sufficient wells, to irrigate the crop if the canal water fails, then the whole of the water stored must be reserved for the perennial irrigation, as the expense of this form of cultivation is great and the loss of a crop is a serious loss to the cultivator, and the area irrigated must be limited to the area which can certainly be supplied with water. In a canal devoted to perennial irrigation, the storage reservoir is therefore limited in size to that required to store the supply available in years of bad rainfall. The supply is about half only of that available in ordinary years, and although the bad years occur at long intervals, the dread of one occurring limits the area of perennial cultivation to that possible under the

assured supply, and further, the dread of a very late arrival of the monsoon rains make it necessary to keep a supply of water stored in the reservoir to meet the requirements of the perennial crops up to the latest arrival of the rains, and, as the rains almost always arrive much before the date, there is then a balance in the reservoir which is not used, and has to be run to waste down the river.

In a canal system devoted to perennial irrigation the reservoir therefore stores only half the normal supply of water, and is not able to use the whole of this diminished storage, but has to waste part of the costly water.

In addition to the waste of storage and river supply a canal devoted to perennial irrigation wastes, or neglects to utilise, almost the whole of the rainfall which falls upon the land commanded by the canal. Allowing for an ordinary rainy season, and ordinary deficiency of supply in the *rabi* season, a perennial crop will require some thirty heavy waterings from the canal throughout the year to bring it to maturity. Whilst a cereal crop like jowari or great millet, in ordinary years of deficient rain, seldom requires more than three waterings, and, as explained above, when the rain has been suitable at the sowing, or early part of the season, and fails at the end, then two waterings or even one is sufficient to produce good crops instead of failure. These two waterings sufficient for the canal crop are only $\frac{2}{30}$ of the requirements of a perennial crop, and hence if the water available be given to *rabi* crops, then the rainfall on all the area irrigated, at least 15 times the area of perennial, will be utilised; and two waterings from the canal will suffice to mature the crops; if on the other hand the water be withheld from the *rabi* crops and be reserved for perennial, then the only advantage obtained from the rainfall is the saving of one or two waterings on the perennial area, and all the rain on the far greater *rabi* area is lost and wasted and the *rabi* crops die. This area is more than 15 times as great as the perennial area; it is really over 20 times as great, for the losses incurred in storing water for the perennial crop during the hot weather will be avoided if the water be used during the cold

weather. During the hot months of the year, the loss in vertical depth by evaporation from the surface of water in a tank is more than twelve inches a month, and hence from every acre of water surface more water is lost during the hot weather than is required to irrigate an acre of perennial crop during the same period. Additional loss is also incurred during the distribution of water for the extra period, and in the hot weather.

This loss by distribution is not easy to determine accurately; there is the loss by evaporation from the water surface of the canals and channels, and from the width of ground kept damp by percolation and absorption, and there is the loss by direct percolation deep into the ground. Irrigation engineers are in general agreement, that, for ordinary systems of distribution where about one-third of the land commanded is irrigated, the loss is over one-half of the total supply issued from the reservoir.

The water which has to be reserved in the storage tank for the perennial irrigation during the hot weather is, therefore, in volume twice as much as is actually put on to the crops, but if it were used for *rabi* irrigation, almost the whole of it would be available for the cereal *rabi* crops, for the loss in distribution is already being incurred, and there will be but slight extra loss due to the extra volume distributed.

The water it is actually necessary to store for an acre of perennial crop is thus considerably more than sufficient for fifteen times the area of cereal crop in the *rabi* season. When the reservoir storage is devoted to perennial, the whole of the water cannot be effectively used, and only half the normal supply can be relied upon.

In order to avoid the heavy losses in distribution wherever perennial irrigation is practised, there is a tendency to concentrate the irrigation as near to the source of supply as possible and to mass the irrigated crop together. In the earlier stages of the life-history of a canal given up to perennial irrigation, this results in the water-logging of some of the land. It is exceedingly difficult to limit the quantity of water required for irrigation merely to the quantity required by the crop, and in order to induce the water

to flow over the ground a depth greater than the crop needs has to be applied, and the absorption of the soil whilst the water is flowing over it takes into the ground a greater volume of water than is required for the crop. This loss can be reduced by subdividing the fields into small plots, and providing numerous small distributing channels, in which there is less waste than when the water flows over a wide area; and if the surface of the ground is well tilled, and smoothed and made even, the quantity of water required is also reduced, but both these methods mean extra labour to the cultivator, and if he has no inducement to economise water, the question to him is merely one of expense, and he has to choose between paying for the extra labour of cultivating finely, and preparing his field for proper distribution of the water, or losing a little of the value of his crop by excess of watering. The profits from this class of crop are, however, so high that the cultivator naturally elects to devote his labour to the cultivation of as large an area of crops as he can obtain permission for from the Irrigation officer, and to overwater his crop.

The ground is thus saturated and the level of the subsoil water rises, and at the same time the irrigation from wells ceases, for the cost of lifting water from wells is so much greater than any water rate yet levied in India, that canal water is always taken in preference to lifting water from wells. Moreover, in a new canal the owners of wells have land prepared for irrigation, and are well off and more prosperous than their neighbours, and are in a better position to meet the expense of the high cultivation required for valuable perennial crops.

Hence, in the early stages of a canal given up to perennial irrigation, the irrigation is concentrated on the area of land nearest to the source of supply, the wells are no longer used, and the fields are overwatered, the subsoil water-level rises, and some lands are water-logged.

In ordinary gardens watered by irrigation from wells only water-logging is not met with; the costly water lifted from the well is distributed with care, and less depth is placed upon the land; the land irrigated is all in the neighbourhood of the well

as the supply obtained is not sufficient to travel far, and the loss in a long channel would be excessive and serious, and the fields are therefore necessarily within the effective drainage care of the well; and the excess of water used in irrigating the field is free to percolate through the ground to the well to be used again. There is this very great difference between garden cultivation from wells and perennial cultivation from a canal; in the former, or garden cultivation, the work of irrigation at the same time drains the land, for the water for irrigation is abstracted from the subsoil water of the fields irrigated, whilst in the latter or canal irrigation, the excess water used is continually sinking into the ground and raising the level of the subsoil water, and either the fields themselves become saturated or, if there be good natural drainage, some lands in the neighbourhood where the drainage concentrates, become water-logged.

The benefits derived from perennial irrigation are so great that the damage to a few fields by water-logging is a comparatively small item in the expense of cultivation, but still it is desirable to get rid of the damage and also to avoid the waste of water, and the way to do this is to sink wells and lower the subsoil water by using it for irrigation. It may seem paradoxical that the remedy for water-logging is increased irrigation, until it is realised that the increase of irrigation is not obtained by adding more water from the canal, but by removing from the ground by means of wells the excess water which has been poured upon the ground from the canal; when this point is understood, that the well is taking water out of the ground and lowering the level of the subsoil water, then it will be clear that the irrigation from the well is also draining the ground; as all the water applied to the surface of a field for irrigation does not sink into the ground, and the crops do consume some water and much is evaporated. If irrigation from wells be combined with canal irrigation, it is possible to irrigate far larger areas than by the canal water alone, and if the wells are used sufficiently, it is possible to arrive at a state of equilibrium when the water withdrawn from the soil is equal to the excess percolating

downwards from canal irrigation, and the level of the subsoil water will remain steady.

It is clear that this desirable result cannot be obtained without the hearty co-operation of the cultivator, and the co-operation can be secured, and the wasteful losses and neglect of part of the available supply of water can be avoided, by working the canal as a *rabi* canal, and giving preference to the *rabi* or cold weather crop, instead of to the perennial crop. In a canal system where first preference is given to *rabi* irrigation the area ordinarily irrigated will be that possible by the supply of water obtained in normal years; for these crops are annual, the sowing of them can be limited to suit the amount of water known to be available, and as the supply is obtained during the monsoon, before the *rabi* crops are sown, the quantity available is known before seed is sown for *rabi*. The reservoirs may then be made large enough to store the supply obtainable in normal years, or twice as much as the volume available in bad years; and the whole of the supply can be utilised and the reservoir completely emptied. The canal may be laid out to irrigate an area twenty times as great as the corresponding perennial canal could irrigate, and crops can be assured on the area in all except the very exceptional years, which occur in the Deccan about once in 20 or 30 years, and even then a large proportion of the area can be irrigated if the canal has a supply from the Western Ghaut or some similar range of hills where the rain never entirely fails.

In the few and exceptional years when the rainfall is good and timely, irrigation is not wanted, but in the Deccan these years are exceptional, and as a rule irrigation is required at some period of growth.

If the applications for permission to irrigate have to be made annually, the cultivators naturally wait until the character of the *rabi* rains has been determined, and if the rains are good water is not applied for, and is not paid for, and if the rains are good at the beginning and a failure at the close, there is a rush for water, all crops requiring it at once, which the canal cannot

meet, and there is not the regularity and certainty of payment for water that is so convenient for the management of a canal.

If payment were made by the volume of water issued, there would be still greater variation, as the demand may be for one watering only, or for watering for the complete season according to the character of the rains, and the endeavours to work a Deccan canal either by payment for area irrigated, or by volume of water issued, have resulted in great variation of revenue from the canal, whilst the cultivators have continually had good crops. As the cultivators were much too sensible to spoil their *rabi* crops by watering them when they did not want it, then, because they did not regularly take the water, it has been given to cultivators of perennial crops who would take it regularly. When once given in this manner, it cannot be taken away again and given back to the *rabi* cultivators, and so the rabi cultivation fell back to its former uncertainty and failure, and to the state it was before the canal was constructed.

Now, if opportunity be given to the *rabi* cultivators to assure themselves and their crops of a supply of water if required, by taking long leases, they will gladly avail themselves of the privilege; the cultivators should not be obliged to take water and so spoil their crops when good rains have supplied them, and hence the payment by the cultivator should be on the area of crops grown. The rôle of a canal devoted to *rabi* is to ensure crops; though the amount of help required from the canal will vary considerably, the cultivator will always have a good crop to pay the canal rates: provided that the rates are levied only on the area on which crops are matured.

This is the plan followed on canals in tracts where there is no rainfall, as in Sind ; in such districts water rates are levied on the area of crop grown, remissions being made when crops are poor and fail, and the same system is the best for land under a *rabi* canal.

The regular growth of *rabi* crops under a canal will encourage perennial irrigation from wells, for when the rainfall is deficient, the irrigation by the canal makes up for the shortage and the

subsoil will obtain the excess water used for irrigation of the *rabi*, and the wells will always have a good supply; in fact, the wells become independent of the rainfall. Wherever wells are constructed, perennial crops may be safely cultivated up to the capacity of the wells for irrigation. The cultivation of perennial crops on these wells in an area served by a canal for *rabi* crops is much less expensive than in a garden served by a well alone, for the labour of lifting the water is very much reduced. During the whole time the canal is running, or for about eight months of the year, it is not necessary, as a rule, to use the wells at all, for the water from the canal can be used for irrigation, and during the remaining four months of the year, the amount of labour for lifting will vary. If the *rabi* rains have been good, and water not issued from the reservoir for the *rabi* crops, then a supply may be available for the whole of the four hot months of the year, and no lifting at all may be required, but as a rule the wells must be worked from one month to three months of the hot weather. In this manner perennial crops are obtained with the labour of lifting water for a few months in the hot weather only, instead of during the whole twelve months, and the land also is drained and the subsoil water kept low.

It will be understood that the subsoil water will rise a little during the monsoon and cold weather, or *rabi* season, whilst crops are being watered, and be lowered during the hot weather only, and hence wells under a *rabi* canal have this further advantage over garden wells, that the underground storage is drawn upon for two and three months only of the year, instead of for the whole twelve months, and hence can be relied on to give a larger supply of water, and irrigate greater areas than an ordinary well in a garden.

Hence a canal devoted to *rabi* at the same time encourages perennial irrigation from wells, and makes it possible to irrigate a larger area of these valuable crops by the help of wells in the hot weather, and the hearty co-operation of the cultivator in working wells, with all the advantages of drainage of the subsoil, and of perennial irrigation is secured.

Now, the condition above described of a canal devoted to *rabi* irrigation and growing perennial crops by the help of wells is not an imaginary one, but is the actual practice and method of management of all the old irrigation works, and may be seen to great advantage in the Bandhara irrigation of Nasik and Khandesh, and in the tank irrigation of the Southern Mahratta country and many parts of India. The canals are small, but they are numerous, and the areas irrigated total to many thousands of acres. The lands under these small works are laid out for monsoon and *rabi* cultivation, and wells are an essential part of each garden, and are used to supplement the scanty hot weather supply. The value of the monsoon and *rabi* irrigation for strengthening the supply to the wells is fully understood. The monsoon and *rabi* irrigation is also massed together, so that the losses in distribution are much reduced, and the water used to the greatest advantage. In many cases the cultivators combine and mass crops of the same character together, and reduce the cost of watching and protecting the crops, and also enable better cultivation to be adopted. There are no water-logged fields in these old works.

Villages with such irrigation are always prosperous; water for drinking is ample for man and beast, fodder is always abundant, and the cattle well fed, crops are assured, vegetables, condiments and spices are grown, fuel is cheap and plentiful, as trees grow well on the boundaries of the fields; the mango, tamarind and other fruit trees grow luxuriantly, and fruit is plentiful, and shade and shelter are provided by the trees for men and cattle. The villages are havens of rest and comfort, and their fortunate occupants are envied by their neighbours and visitors, who are without the advantage of irrigation

The abundance of fodder is of the very greatest value. In all the famines so prevalent in India, the maintenance of the lives of human beings is much more easily provided for than the protection of the cattle. For men, grain only has to be carried, but for cattle fodder is necessary, and the carriage of large bulky supplies of fodder from great distances is most costly and difficult.

The very great value of an abundant fodder supply on irrigation works is not adequately recognised. Without the cattle, the lands cannot be properly ploughed and cultivated, or produce carried to market, and the value of cattle is not limited to the work done by them, but the manure produced is also required for the treatment of the land.

Wherever fodder is abundant, there is no famine, the cattle are strong and healthy, and the land well tilled and ready to use to the very best advantage all rain that may fall, and the district is maintained in a high state of prosperity. On the other hand, if there be no fodder, the cattle die, are not available when rain does come, and there is difficulty in preparing fields for cultivation and the famine is prolonged. Moreover, it is not easy to replace cattle when the majority of those in the district have died, and the effects of a great loss of cattle are felt for a number of years, until young stock have grown up to replace the loss. There are many streams in India where the supplies, if stored, would usually be sufficient for large areas of *rabi* irrigation, though at times they would fail for perennial irrigation, and where, if irrigation works were constructed and worked as *rabi* canals in the manner described in this note, permanent prosperity could be brought to large areas now liable to frequent failure from precarious rainfall. Such works would pay handsome dividends, if they shared in all the benefits they confer.

They must be designed to distribute the water proportionally and equally to the area commanded: and the area must be limited to that which can be saved by economically combining the water available for irrigation with the rainfall on the land. The cultivators must be free to use as they wish the water allotted to their area of land, taking water when they require it, and not using it when the rainfall is sufficient for their crops, and then at all times, whether they use canal water or not, the cultivators will have a good crop.

The canal will change the method of cultivation from a hazardous gamble on the chances of a precarious rainfall, to a methodical business-like management of the facilities for cultiva-

tion with a certain return. The canal must not be judged by the quantity of water used, or by the area irrigated, but by the general prosperity of the area secured ; and both cultivators and canal should share in the prosperity. Whether such canals will be constructed depends mainly on whether they can be made to pay a fair interest on the cost of construction, and also to pay the cost of maintenance. Whether they will pay depends on the manner in which canal rates are levied. If water rates are paid on the area irrigated annually or on the water issued annually, then, unless very high charges are made in times of drought and scarcity, the canals would be worked at a loss, and if it be clear that canals will be worked at a loss, there is small chance of their being made.

But cultivators in these districts of precarious rainfall are keenly desirous of the benefits and help of such *rabi* canals, and will very willingly pay for them if allowed to do so, and if the canals share along with the cultivators in the benefits they have conferred, and a canal rate is levied annually on all the crops brought to maturity in the tract served by the canals, a moderate rate, easily paid, will be sufficient to make the canals profitable. This payment will not be on the area of land commanded, but on the area of crops grown and matured in that area, so that the means of payment will always exist, and there need be no arrears. There is a great future for canals in Central India and the Deccan if worked on this system, *rabi* areas twenty times as great as the area possible if the water were devoted to perennial irrigation can be irrigated, and at the same time perennial irrigation under wells will be encouraged, and the area of perennial thus possible will be at least as great as the area of perennial to be obtained by devoting the storage entirely to that class of crop. The country generally, therefore, benefits by the whole area of *rabi* crops obtained. Under a perennial canal the *rabi* crops are abandoned and lost, but under a *rabi* canal the greatest area of *rabi* possible is obtained, under canal irrigation, and also the perennial crops in addition, by the help of wells. The canal rate to be obtained from 20 acres of *rabi* is more than can be obtained

from one acre of perennial irrigation, and both canals and the country profit by the wider distribution of the water in a *rabi* canal, and though the gains of a few individuals will be less than under a perennial canal, the total gains will be greater, and more evenly distributed and, many more people will be made prosperous.

Irrigation should be so directed as to use to the greatest advantage the supplies of water available both from the streams and from the rainfall, and the *rabi* canals are able to use both to the full extent of the storage reservoirs practicable.

THE FIFTH MEETING OF THE BOARD OF AGRICULTURE.

By F. M. HOWLETT, B.A., F.E.S.,

Secretary to the Board.

The fifth meeting of the Board of Agriculture was held this year at Nagpur from the 15th to the 20th of February; Mr. J. Mollison, Inspector-General of Agriculture in India, was President, and the number of those who attended was forty-four as compared with fifty-one at the meeting in 1908, the decrease being in accordance with the resolution passed last year to limit the number of members to thirty-eight. On this occasion there were eight Imperial and twenty-five Provincial members: Mr. Noël-Paton and Mr. Burkill also attended, and there were eight visitors. The Hon'ble the Chief Commissioner was present on one day, and it is not too much to say that the speech which he contributed to the discussion on methods of getting in touch with the cultivators was listened to with very real pleasure and profit by every man present. He is the first Governor of a province whose interest in Agriculture has carried him so far as to attend a meeting of the Board: we may hope he is not the last.

Viewed in the light of previous meetings, the one held at Nagpur was of considerable interest, as affording evidence of the evolution of the Department along natural lines of expansion and consolidation. Five meetings have now been held, and perhaps the present occasion is a suitable one for briefly comparing some of the subjects discussed at these meetings, and thereby getting a partial view, in some sort of perspective, of the work which the Department is carrying on. That this view can only be very incomplete is due to the fact that I omit

altogether one constant feature of every Board meeting, the Programmes of the Imperial and Provincial Departments and of the Native States, as I have neither the ability nor experience necessary for their proper consideration. The careful criticism and, if necessary, amendment of these programmes constitutes no small part of the Board's work, and it is to the programmes themselves that we must look for a detailed account of the methods whereby the aims of the Department are being furthered in each particular Province. It is largely in the programmes too that we shall find the record of that continuous spade-work and constant effort at adaptation to environment on which all progress must in the end be based. Nevertheless, from the other items on the agenda, we can get some idea of the stage of development which the Department has now attained.

The subjects for discussion at the first meeting, held at Pusa on January 6th, 1905, can be classed under five heads.

(1) The investigation, improvement, and extension of particular crops.

(2) Matters connected with methods of cultivation, buildings, and implements.

(3) Veterinary.

(4) Training and education.

(5) Co-ordination of work and general organisation.

This meeting of 1905 was in a sense prophetic, for practically all the subjects discussed by subsequent "Boards" fall into one or another of these same five divisions, though all the divisions are not represented on the agenda of every meeting. Taking division (1), we find that in 1905 the improvement and extension of the cultivation of cotton and jute were considered: in 1906 of wheat and tobacco; in 1907 of sugar-cane and cotton: and in 1908 of fibre crops in general, excluding cotton and jute. In each case the directions in which enquiry would be profitable were decided, and the work continues to be carried on along these lines, the methods adopted and results gained being indicated by the programmes and reports of the officers concerned. No special crop was considered at the 1909 meeting. Under divi

sion (2) were considered in 1905 Irrigation, in 1906 Commercial fertilisers, in 1907 Commercial fertilisers, the utilisation of River Silt, and standardising methods of soil-analysis, etc. There was no subject in this division on the agenda for 1908, but in 1909 the size most suitable for Experiment Farms and Demonstration-areas was considered. (3) Veterinary matters were discussed at the meetings of 1905, 1906 and 1907, and the improvement of Indian poultry in 1908. The subject did not figure on the programme for 1909, and the connexion between the Agricultural and Veterinary Departments is somewhat less close than might have been expected from the forecast of the 1905 meeting.

	(1) Consideration of particular Crops.	(2) Methods of cultivation, buildings, implements, etc.	(3) Veterinary.
1905 ...	Cotton and Jute ...	Irrigation	General Veterinary.
1906 ...	Wheat and Tobacco ...	Commercial Fertilisers ..	General Veterinary.
1907 ...	Sugar-cane and Cotton ...	River Silt, Commercial Fertilisers, Standardising analytical methods.	General Veterinary.
1908 ...	Fibre-crops, excluding Cotton and Jute.	—	Poultry.
1909 ..	—	Results of experience regarding the most suitable size for Farms & Demonstration-areas.	

The two questions which confront a Department such as ours are, first, what is to be done, and, second, how to do it. Accordingly, we find that at the first three meetings general questions of crops, methods, and stock occupy a prominent position in the records of discussion. Only rather special branches, fibres and poultry, had a place on the programme for 1908, while in that of 1909 there was no subject in any of these three divisions, except the one relating to the most useful average size for farms and demonstration-areas. It might, at first sight, seem that these subjects were not receiving attention at the present time. This of course is very far from being the case. During the first three or four years, investigations in many different directions were started on what appeared to be the most promising lines. To ensure the most advantageous use of the energies of the

Department it was necessary that these lines should be determined by consultation between all the officers concerned : hence the appearance of these subjects for discussion by the Board. Once the aim and method of an enquiry had been decided upon in consultation, however, the need for discussion as a separate subject no longer existed, so that while enquiries into the extension or improvement of particular crops (including all those shown above and many more) continue to be actively carried on and extended in every part of the country, their progress is recorded in the reports and programmes of the officers responsible. Work in these directions is settling ; not into a groove, but so as to flow into and fill the lines of a foundation on which the work of future years may firmly rest.

In Division (4) Education, we find that in 1905 the Board was considering the training of Farm Overseers and the possibility of establishing classes for boys at some of the experimental farms. In 1906 a curriculum for the new agricultural colleges was drafted with the idea of fixing more or less the standard of teaching and the ground to be covered. In 1907 and 1908 educational matters remained rather in the background: the colleges were in several cases in course of construction, and we find only a mention of the provision and training of agricultural engineers (1907) and a discussion of the course of studies suitable for Indian officers whom it might be found necessary to send to Europe or America for advanced training in agriculture (1908). In 1909, however, educational questions were again well to the fore, this recrudescence being due to the awakening activity of the Agricultural Colleges. Courses of instruction are now being given in Madras, Bombay, the United Provinces and the Central Provinces, the Punjab College will open almost immediately, while the Bengal College is expected to open next year, and will admit students from Eastern Bengal and Assam, where, as in Burma, there is at present no college. The difficulties hitherto encountered have been due to the insufficiency of the teaching staff to deal with large numbers of students, the difficulty of keeping the subordinate teaching staff abreast of

the progress of agricultural practice in all parts of their Province, and difficulties due to the wide range of the curriculum drafted by the Board in 1906. One further difficulty has been that of determining the class of student which it is most desirable in the interests of agriculture to attract. This is, of course, a matter of fundamental importance, but its settlement must await the accumulation of further experience, that hitherto gained being too small to admit of the question being finally decided at present. The choice laid before the teachers of agriculture in the Provinces rests mainly between two alternatives : to train an agriculturist in science, or to train a science graduate in agriculture. If the raw material is to be an agriculturist, it is obvious that the educational process to which he is subjected will not be equally applicable for use on a man who has already graduated in science, and until some degree of unanimity on this point is reached, the nature of the teaching and arrangement of the course of instruction must either be worked out independently for each Province or must remain to some extent tentative. Although a Scientific Agriculturist and an Agricultural Scientist are possibly not dissimilar, they are not identical, and the uncertainty as to the class of men which the Provincial Colleges will produce has retarded any very precise definition of the nature of the higher training to be given at Pusa. It is, however, agreed that its aim shall be to produce men capable of carrying out specialised work in the Provinces ; the exact lines on which the training will proceed will be dependent on the particular investigations in progress at the time, since it is recognised that the main object of Pusa is research, and that the present Imperial staff is insufficient to carry on such research and at the same time to conduct students through a course of training which is unrelated thereto. A provisional Pusa syllabus has been drawn up, which is intended to hold good for the present until the Provincial colleges are in full swing and able to send students fully qualified to profit by post-graduate courses of a somewhat higher type. To deal with all educational questions which may arise in the future and generally to

co-ordinate the educational work, it was proposed (1909) that a permanent Committee should be established. The matter will be considered at the Pusa meeting in 1910. The training best fitted for managers of Agricultural stations was also discussed and recommendations made.

In Division (5) we have placed all matters connected with co-ordination of work and general organization. By this is meant the proper adjustment of relations—

(*a*) between the Cultivator and the Department;
(*b*) within the Department itself: internal organization;
(*c*) between the Department and the Public.

Education, which we have placed in a separate division, would really come under (*a*), for one of its chief aims is to provide men who will act as intermediates, more intimately linking up the untutored ryot at the periphery with the expert officer at the organizing and distributing centre.

A tabular statement roughly shows the line of progress of these subjects :—

	(*a*) Relations between Cultivator and Department.	Education.	(*b*) Internal organization.	(*c*) Relations between Department and the Public.
1905	How to bring Provincial officers into closer relations with cultivators.	Training of overseers. Farm-classes for boys proposed.	How to bring Imperial officers into closer relations with the Provinces.	Publications, Memoirs, Bulletins, and the Agricultural Journal of India.
1906	......	Standard Curriculum for Agricultural Colleges drafted.	...	......
1907	......	Training of Agricultural engineers.	...	......
1908	How best to get into touch with cultivators.	Course of studies for Indian officers sent to Europe or America for training.	Expansion of Entomology and Mycology. Future constitution of the Board.	...
1909	How best to bring the proved results of experimental work to the notice of cultivators.	Training of Farm-managers. The most suitable type of student to attract. Difficulties met with. Training at Pusa. Permanant Education Committee.	Touring of officers outside their own Provinces. Transference of suitable methods, implements, and crops from one Province to another.	Utilization of the Press in disseminating the aims and methods of the Department.

As has already been pointed out, the Board programmes have shown a progressive dwindling of subjects in divisions (1), (2) and (3), as these subjects became more and more absorbed into the programmes of the Provincial and Imperial Departments. On the other hand, divisions (4) and (5) have of late claimed increasing attention.

It is this which seems to me to give us some indication of how far the Department has progressed along the path of development. The common yellow wasp of our bungalows affords a rough partial parallel. When the Queen wasps emerge from their dormant condition in the Spring, they at once build a single cell, and in this cell they set about rearing an assistant-wasp. When this assistant-wasp has reached the adult stage, the pair of them join forces in laying down a larger nest and training up within it a numerous brood. By modifications of food and treatment the young wasps thus reared may have their development influenced in pre-arranged directions so as specially to fit them for special duties. At long intervals a Queen is produced.

If we may with due respect regard our Official Chiefs as representing the Queens, then their staff of trained European and Indian officers would be the assistant-wasps. Together they have now organized the work of rearing the big brood. The cells or colleges are made, and their occupants are being supplied with the kind of food which appears most likely to result in a sound and vigorous growth of workers. In this matter the wasp has the advantage of "instinct," that concentrated essence of ancestral experience which tells it exactly what grub is most suitable for its maggots. The Department, unfortunately, cannot decide by instinct on a course of training, but will have to modify its methods in accordance with the experience it can get for itself. As with the wasps, special methods will be employed for special purposes, and future development will make for expansion and differentiation, division of labour in a co-operative body.

Reference to the table will show that with one exception all the subjects discussed this year fall under divisions (4) and (5), Education and Organization. We can accept the analogy of the

wasp's operations and look on agricultural education as being ready for expansion into a wider activity than ever before. If in Division (5), Organization, we look at section (a) we find that a full and valuable report on methods of reaching the cultivator has just been completed. In section (b) were discussed methods for facilitating intercourse between Province and Province, making for general increase in "permeability," not only by affording greater facilities for the transference of good implements crops, and the like, but by a free passage and circulation of good methods and new ideas. The Chief Commissioner in the speech already alluded to touched on the connexion between concentration and expansion, pointing out that methods of concentration were valuable only until results had been obtained, when they should give place to methods which would secure as soon as possible wide dissemination and utilisation of these results. This holds good not only for particular problems, but in a modified degree for the work of the department as a whole. When a caterpillar has absorbed and digested a certain amount of food, it begins to swell, its internal arrangements undergo some slight reorganization, the skin bursts, and it expands into a fresh stage, only to renew the process of feeding and to moult again later on. Divisions (1), (2), and (3) represent the "food" which is being absorbed, the facts which have now been assimilated and co-ordinated sufficiently to warrant expansion. Divisions (4) and (5) in their increasing importance give us the visible evidence of that expansion. In short we may look on the 1909 meeting as showing us the department in process of moulting.

I have hitherto left untouched one subject which came up for discussion before this meeting, and that too a subject which more clearly than any of the others indicates the expansive tendencies abovementioned,—relations with the Public and the Press. Advertisement in the ordinary sense of the word is not the only consequence of an increased publicity, nor is the ryot the only man who is interested in agriculture.

The wasp is concerned only with the rearing of its brood of young. Beyond providing them with suitable food it does little

except protect them from weather and from enemies. This it does by unceasing personal supervision and by isolating the little community as far as it can by hanging the nest on a thin stalk, so as to narrow the approaches available to unfriendly parasites, the *bannias* of the insect world. The Department is adopting precisely similar methods, except that it is using co-operative banks instead of a stalk. But while its primary work undoubtedly does lie in bettering the condition of agriculture by working through the cultivator, there remain other directions in which its possibilities seem not fully utilised. Leaving altogether out of account the officials of other departments whose work may from time to time be assisted, and taking only the great commercial and planting communities, there is little doubt that only a small proportion of their members realize that there is a Department which is not only competent to give real help with regard to many of their recurrent or occasional difficulties but is actually desirous of placing its special knowledge unreservedly at the disposal of all whom it may benefit. For spreading the realization of such an idea the ordinary type of official publication is not the most suitable. Probably the mere fact that it is an official publication handicaps it at the start. To attract, to interest, and to help the general public means also to build up a backing of public opinion and public understanding of the greatest value. To do this there is little doubt that our present publications are not altogether well adapted. Yellow is the hue which is commonly supposed to attract the man whose interests are commercial: might not a tinge of his favourite colour be allowed to suffuse some portion of our annual literary output?

If we cannot bring ourselves to take even one step on the downward path which leads to the level of the "Daily Mail," it might be possible to produce periodically something on a rather lower or at least different plane to that on which the Agricultural Journal stands. The Journal is an extremely valuable publication whose high standard should not be degraded, but at the same time there is no doubt that it is less suited to the commercial man than to the scientific student of agricultural

methods. A comparison with such journals as those of the Australian Departments of Agriculture throws into relief the difference between the two types. The Provincial journals constitute a step in the direction of the second. Both are valuable. Is there not now in India a community of agriculturally-interested business men large enough to justify the publication of results in some more homely and digestible form, even perhaps embellished with those fascinating advertisements which so greatly enhance the interest (and value) of all ordinary technical and trade journals?

Here the wasp simile fails, because our activities are two-sided while the wasp's are only one-sided. We might try another, and liken the Department to a lump of wax consciously trying to fit itself into a mould whose lower half is the soil and the cultivator, the upper half the public. It is steadily settling into the lower half; contact with the upper is as yet very imperfect, and the wax must either expand to meet it, or bring it nearer to itself, or do both or neither. Complete contact can never quite be achieved, because both halves will vary their shape in accordance with changes in their requirements and economic conditions. The question of how to get in touch with the cultivator has been most fully considered by the last two Boards. If development is to continue, if an attempt is to be made to fill the upper half of the mould as well as the lower, it cannot be long before the Board programme has as its main feature a discussion on "how to get in touch with the Business Man."

THE CULTIVATION OF SHELLAC AS AN AGRICULTURAL PRODUCT.

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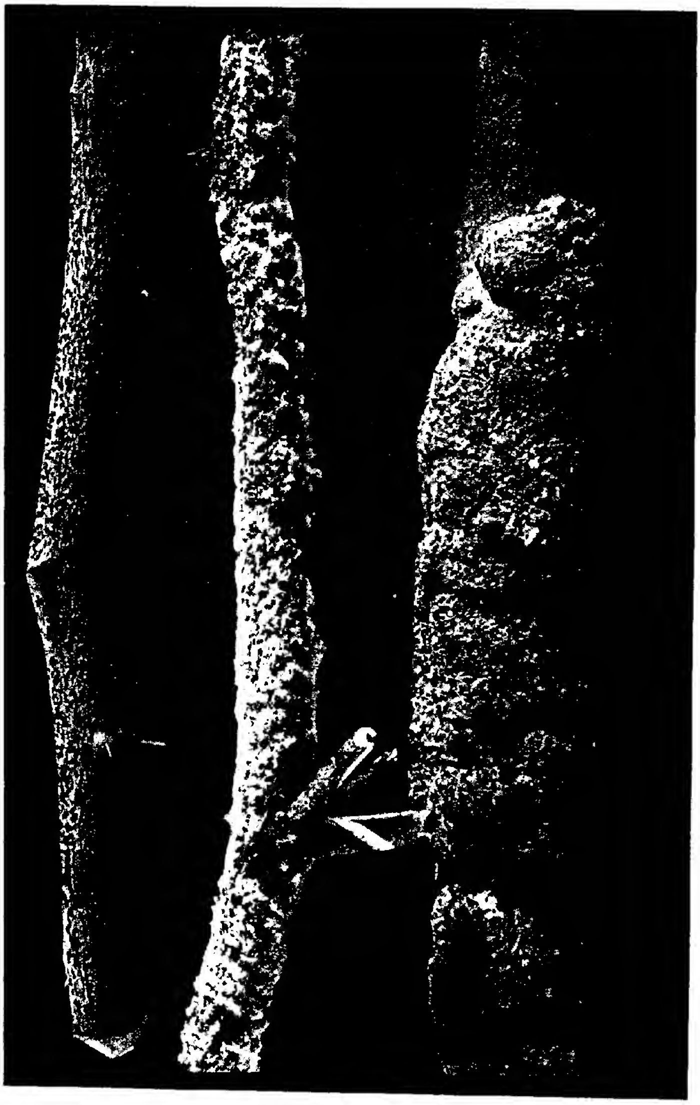
SHELLAC is the resinous covering of several species of scale insects, which live upon a variety of trees, suck out the sap and exude a covering of a resinous nature as a protection. These insects occur on a very large scale in the forests of India and are cultivated for the value of their covering. The raw material is collected from the trees and is worked up into various forms, more or less purified, in which it is exported from India. A very large amount is also used in this country, and there is a constant and increasing demand for this product.

Shellac is recognised as one of the most valuable of forest products while its value as an agricultural product is very largely neglected. It is this aspect of lac cultivation that is discussed here, as there is a large field for extension in this product in the agricultural areas of India, on lines quite apart from those on which the forest product is developed.

Shellac is produced by scale insects of the genus *Tachardia*, of which four species are known in this country at present while there are probably more. The scientific discrimination of these species has never been done nor is it for our immediate purpose necessary but the fact must not be lost sight of; it is of the greatest practical importance, since the species have differing foodplants and seasons, and in commencing cultivation one must know the season of the species one is dealing with as well as its alternative foodplants. Unfortunately not much is known of this aspect of the subject and those who have written about lac in the

PLATE XXV.



A. J. I

LAC ON BER.

On the left a twig, showing the young settled down shortly after inoculation. In the middle, half-grown healthy lac showing the characteristic white fluffy appearance.

On the right, mature lac from which the young have emerged. In the middle, is a single hole from which has emerged the moth of a caterpillar that feeds on lac. (All natural size.)

past have almost wholly ignored the fact, to the confusion of the subject and the failure of experimental trials.

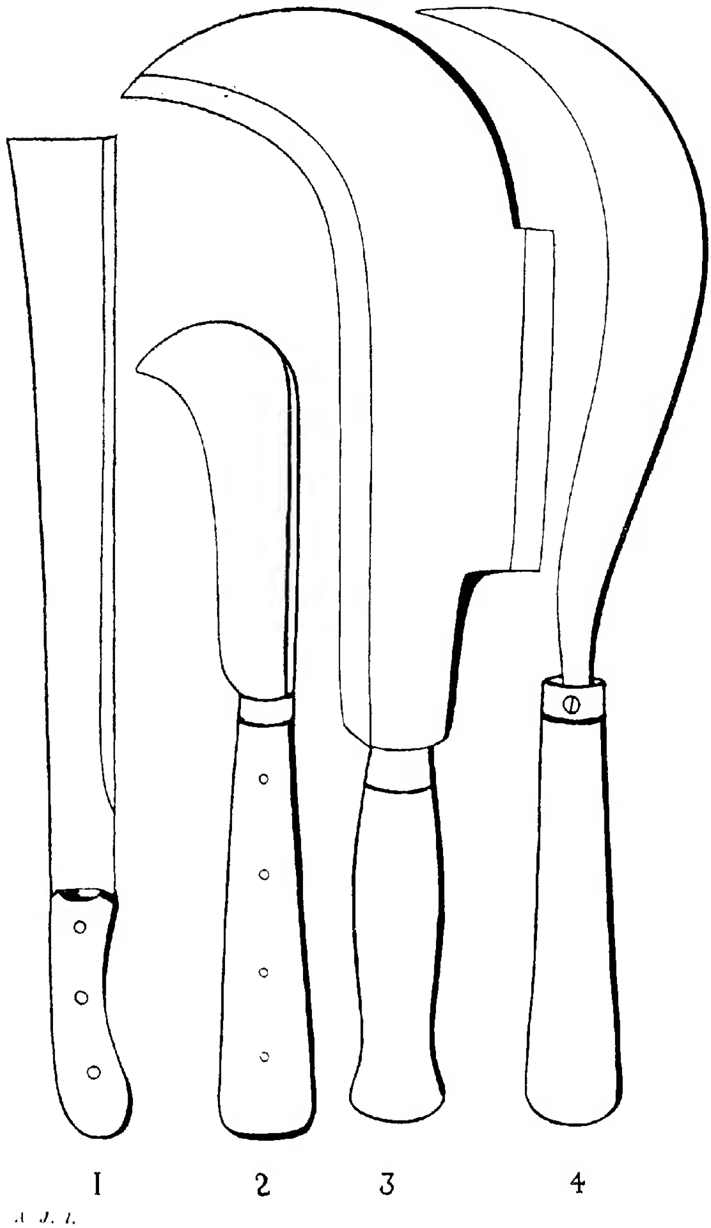
Ber Lac.—We will consider here first the lac, which is cultivated on the ber or wild plum tree (*Zizyphus jujuba*). Like other lacs, it has two broods in the year; in Behar, the eggs hatch in June, the young insects grow until October, when they are full-grown and lay eggs; these eggs hatch and the insects grow until the following May. There is thus an emergence of young insects in June and in October, varying in date from season to season but always about then. In commencing cultivation one must have trees ready pruned, or in such a state as to take the insects, by June or October and one must have arranged for a supply of brood-lac at that date. The seed is then "inoculated" or put on the trees, and by end of September, or middle of June, the young insects produced by that brood emerge and are put on to other trees which must be ready for them. The trees on which this first crop were grown will then be ready for a fresh inoculation by the following June or October, when the eggs of the second brood hatch out. Thus each tree bears one crop a year and rests between, some trees bearing lac from June to October and then resting for the cold weather, the others bearing the crop from October to June and resting during the rains. During the resting period, new shoots grow out and are ready for the next inoculation. In order to prepare the tree for the first inoculation, it must be pruned long enough beforehand to have grown stout new shoots by the time the brood-lac will be ready. In starting cultivation then, one prunes as many trees as one will have brood-lac for, say six months beforehand; when the lac insects are hatching out, one puts the branches on to these trees and "inoculates"; at the same time one prunes more trees to be ready for the next inoculation. After that no more pruning is required, except when putting lac on to trees for the first time, as the mere cutting off of the lac-bearing shoots when the crop is ripe, is a sufficient pruning and provided every tree bears a crop once a year, the mere reaping of the crop is the natural pruning. In Behar, the sequence would be: December 1909:—Prune trees

and arrange for seed-lac. June 1910 :—Put lac on the pruned trees (*i.e.*, inoculate) and prune more trees. October 1910 :—Use the lac from the first trees for the second lot. Prune more trees if required for the next inoculation. May 1911 :—Put lac from the second lot of trees back to the first and on to any new trees.

The sequence will be the same for every kind of lac and tree, depending on the season at which that lac matures and can be inoculated, where inoculation is done in this manner on the shoots.

For successfully working lac, one must be familiar with the more important points of the life history of the insect. These are illustrated on Plate XXIV, and can be readily observed on the tree. When one obtains seed, one gets a branch encrusted with lac, this being the united covering of a large number of full-grown females. These are full of eggs, inside the resin, and these eggs hatch to little insects, which emerge from the cells and crawl about on the branch. When this branch is fastened to another, the young insects crawl up the latter and fasten themselves down. Plate XXV illustrates the young insects, fastened down in abundance on the twig. The young active insect is shown in Plate XXIV. It is very small, reddish in colour, with three pairs of legs and a pair of feelers : it walks actively till it finds a suitable spot where it inserts its beak into the tissues so as to get food and then settles down. At the first moult it becomes legless and scale-like, a fixed insect as shown in Plate XXIV. From this time, if a female, it never moves. If a male, the perfect insect (after some weeks or months) comes out and mates with the immobile females. So that, some time after inoculation, the males will be seen walking about on the branch. The males are winged or wingless, and are small reddish insects as shown on Plate XXIV. For ber-lac, they emerge in August from the June inoculation, in January-February from the October inoculation. The appearance of these male insects must not be confused with the emergence of the young insects. The males mate and die ; the females then grow rapidly and secrete shellac until their coverings unite into the fully developed lac incrustation.

PLATE XXVI.



VARIOUS FORMS OF PRUNING KNIFE.

1. A good pattern, a heavy straight blade for pruning.
2. A tea-pruning knife for trimming cut-ends.
3. A bill-hook for very heavy work on big trees.
4. The ordinary Indian pattern made in the bazaars at a cost of eight annas.

Each insect has white filaments projecting through the shellac covering, and these give the incrustation a white appearance denoting health. These filaments keep open a way for the excrement and for the admission of air. The female is now encased in shellac, and her body becomes full of eggs. These she lays in the cell and gradually recedes before the eggs, her body shrinking as the eggs are laid till she dies having laid her eggs. This occurs in June or late September for ber-lac and the eggs then hatch.

The above is an outline of the life of every lac insect and the important point is to know the emergence of the males as well as the emergence of the young. Plate XXV shows well the appearance of half-grown lac with its fluffy white covering and this is a sign of health and vigour. The insects drop their liquid excretion, which, drying on the leaf of the plant, provides a medium for the growth of sooty mould, thus making the leaves black ; this is immaterial and is not a sign of disease.

The lac insect requires to be placed upon parts of the plant which have a soft rind and will yield abundant juice ; the best position is on newly-grown shoots which are not too small and, in actual practice, inoculation should be done on robust new shoots and in such a way that the lac insect does not cover the shoot too far up towards the tip ; when the stick of lac is put on the branch, the young swarm off it and walk on to the new branch ; they settle down at once, in groups on the shaded side of the twig away from the sun, and the first emerged settle down nearest the point to which the stick is fastened, the later ones moving further and further up the shoot ; when the shoot is covered for a sufficient distance the stick of seed is removed to a fresh place so as to avoid over-inoculating a shoot.

Inoculation is done by tying the sticks of ripe lac on to the branches of the prepared tree, either across two shoots or along a single shoot, this depending upon the size of the shoots and of the mother lac. If the stick of mother lac is big enough to inoculate two shoots, one ties it with its ends resting against two shoots, both of which will be inoculated.

Experience is needed to know the time when the lac is ready to emerge and to be put on to the new shoots. The appearance of the first young ones is a guide; if experience has shown the actual dates in previous seasons, it is better to cut the lac beforehand, say a week before the time of emergence but only experience can decide this for each locality. One must then at once cut all the lac, cut the branches into lengths of eight to ten inches, rejecting those parts not covered with lac and either apply them at once to the new shoots or stack them carefully on two parallel bamboos with the ends of the sticks free till there are numbers of young insects on the ends of each stick; the sticks are then used for inoculation. After a week or so, the sticks are removed and brought in for scraping. The lac is scraped off the stick and well washed; in washing, the lac dye is removed and used as dye or as manure; the washed lac (seed-lac) is put up after drying and sold.

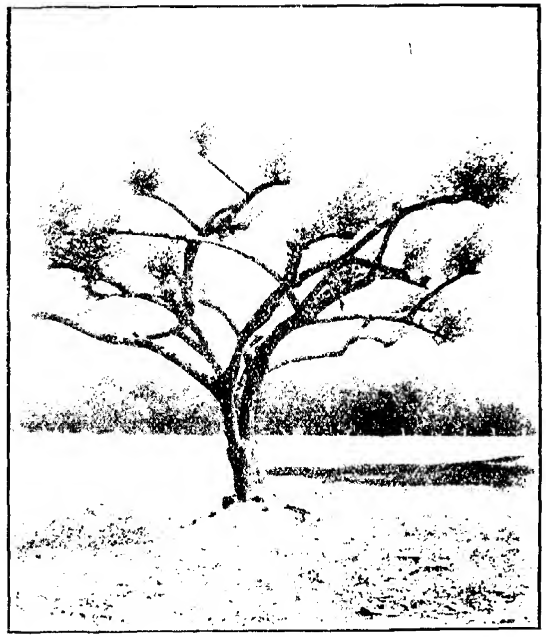
If all the lac is not being used for inoculation, that not required for inoculation is cut before the emergence of the young and is at once scraped and washed or is stacked to allow of the emergence of the young. Better lac is got and a larger quantity and this work should all be finished before the inoculation is to be done.

As stated above, there are two crops on ber, one obtained in May (Baisakhi) and the other in October (Kartiki). The former is the best, partly because it has longer to mature, but also because it is much less attacked by enemies. If a cultivator has 25 trees, he should inoculate only five in May for the Kartiki crop, to provide seed for the other twenty for the Baisakhi crop, and always only so many trees should be inoculated for the Kartiki crop as are necessary to provide seed. If one is increasing one's stock and all the seed-lac required is not available, one inoculates as many trees as possible each time.

Pruning.—Photographs are reproduced here showing a pruned tree; this tree was a very vigorous tree and the pruning was very severe. Old trees will not bear so drastic a pruning but the system is the same; one cuts every branch back to stimulate a bushy growth of strong shoots. One should do this

PLATE XXVII.

A. J. I.
Tree very severely pruned; 3rd December 1907.



The Tree on 3rd March 1908.

in January for the June inoculation. For pruning one requires simply a heavy knife; we illustrate some patterns of which the long straight one (No. 1) is the best. Pruning must be done with straight clean cuts, leaving no jagged ends in which water can lodge to cause decay. The proper pruning is a very essential thing if the vigour of the tree is to be preserved and it is a wise precaution to tar the cut ends. After the first heavy pruning only the light pruning done in removing lac bearing shoots is required.

Cost and Yield.—We cannot estimate the actual cost of commencing cultivation because the initial cost of seed-lac varies very much, as does the cost of labour. At Pusa, we commenced by buying twenty-five bundles of seed-lac for Rs. 25; we inoculated 118 trees, mostly small ones, and the work of pruning and inoculating cost Rs. 12-7-6. In the following October we inoculated 150 trees, of which fifty were large and fifty medium in size; in June we inoculated 353 trees and a quarter of an acre of arhar (*Cajanus indicus*) at a total cost to date of Rs. 72; against this is to be put the sale of lac scraped after inoculation, amounting to Rs. 55. After this the profit and loss account is useless as a large part of the lac is distributed over scattered factories in Behar from which returns are not available. The approximate yield from this area has been ten maunds, selling now at Rs. 200 and giving a profit of Rs. 185 on the total crop plus over a thousand trees inoculated and a quarter of an acre of *arhar*.

The following is a very reasonable estimate of the expenses, etc., for a cultivator owning twenty-five trees, allowing lac to be selling at Rs. 20 per maund, the present approximate price, the lowest for eight years :—

FIRST YEAR.

	Rs.	A.	P.
Pruning twenty trees, one coolie, three days, at 0-2-6 per day ...	0	7	6
Seed-lac, 25 bundles at 4 as. each	6	4	0
Inoculating trees	0	15	0
Scraping lac	0	10	0
Knife	1	0	0
Total ...	8	4	6

SECOND YEAR.

		Rs.	A.	P.
Dressing the trees, one coolie, 2 days	... ...	0	5	0
Inoculating	... ...	0	10	0
Scraping lac	... ...	0	10	0
Miscellaneous	... ...	0	7	0
	Total ...	2	0	0

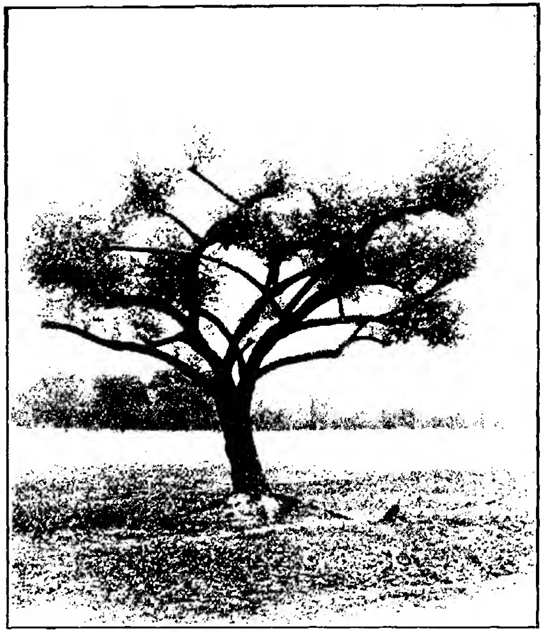
Lac obtained from seed purchased	9 seers
Lac obtained in first year	½ maund
Lac obtained in second year	½ maund
Total ...	1 m. 9 s.
At Rs. 20 per maund	Rs. 24-8-0

The net profit is Rs. 14-2-6 and his annual profit Rs 8.

This is an extremely conservative estimate, as a yield of only two seers per tree is very small. A large tree will yield up to ten seers and more if properly inoculated, and we have based our figures on the constant use of the lac for seed; if he cuts the bulk of his lac obtained in May before the emergence of the larvæ, not using it for seed, he should get a yield per tree of Re. 1 at least. We have also included in our estimate the labour as a charge. Where the cultivator does this himself, as he should do, the actual money return is more, and practically, after buying the initial seed-lac and the knife, there are no expenses and only a few days labour twice a year.

We have at present discussed only ber-lac, because it is the lac that will be of most value in the agricultural areas of India on large scale. Ber lac is second only to kusum-lac in value, as a cultivated lac; the tree grows very freely on neglected land in many parts of India; it is found wild in uncultivated land to a very large extent and covers much land that is otherwise unprofitable. In Behar land covered with ber is commencing to yield a good return without cultivation or special growth of trees, by utilising the existing trees; the trees are cleared, pruned and inoculated and where such trees occur they will yield excellent lac and are already, on some Behar factories, bringing in a return. The bulk of the lac grown at Pusa has been distributed to these

PLATE XXVIII.



A. J. I.
THE SAME TREE AS IN PLATE XXVII ON 3RD APRIL 1908.

THE TREE READY FOR A FULL INOCULATION.

factories, and has done well. Wherever ber is available, there can lac be grown, unless the climate be a very dry hot one, and it is necessary only to procure the seed-lac in the first place. In parts of Bengal, as in the Santal Pergunnahs, ber is extensively cultivated for lac, to the displacement of other crops and it is the best of the available trees for this purpose, in agricultural areas outside the hills.

Other kinds of lac.—Until a complete survey of Indian lacs is made, it is not possible to indicate the scientific name of the various lacs that occur. As a quite distinct variety is the lac found on kusum (*Schleichera trijuga*), the best lac in India. In the hill tracts of Bengal it is the best and most extensively grown lac; but the tree is of limited occurrence in agricultural areas and it is as a forest lac that it is pre-eminent. Where the tree occurs, it is above all suited to lac cultivation, and should be used. The lac matures in July and in January, its seasons being quite distinct from those of ber lac; kusum lac must be used for its inoculation.

Far more important as a lac in agricultural areas is the pipal lac, found on a variety of fig trees (*Ficus*, spp.). It is widely spread over India and is a source of the lac used in the manufacture of bracelets and lac turnery. It is not cultivated; when a tree has a crop, the crop is cut or is collected when it falls off; reproduction is in the former case effected from fragments left on at gathering, in the latter case is natural. The insect occurs in the same way as many scale insects do and, while there are two broods a year, about the same time as ber lac in Behar, a crop is usually obtained only once in two to three years, because there is no system of inoculation Nor is such a system possible; such trees as pipal do not lend themselves to pruning and inoculation and the utmost that can be done is to spread the lac from tree to tree by ascertaining the season at which the young swarm and then tying twigs to all pipal trees not already infected In such a manner there could be a very large extension of lac production, which would be improved by some care in gathering the lac properly and in leaving on a sufficient amount to serve as seed.

Ber lac grows upon the dhak or palas tree (*Butea frondosa*) and upon arhar or tur (*Cajanus indicus*). It is cultivated upon both and both plants are a valuable source of lac. Where dhak is found, it should be used and seed can be obtained from arhar if available. Attempts are now being made to utilise the dhak trees on otherwise unprofitable lands in the United Provinces, but it is not certain that they will succeed. Arhar is used in the Central Provinces and Assam, and is being used in Behar. The difficulty lies in getting good strong plants at the right time and, if one is to inoculate in both May and October, the crop must stand for 15 to 24 months in the ground. It is thus a matter of local conditions if the plants will stand this. In Behar, the plants in February are pruned for the June inoculation or cut down for the October inoculation, but it is by no means certain as yet that even in Behar it will be profitable.

Another lac grows upon litchi (*Nephelium litchi*) and siris (*Albizzia lebbek*). It is a very good lac but is not of much importance. Litchi is of no value as a plant to grow it on, and its other foodplants are not very good.

A very important plant is the babul (*Acacia arabica*), which in Sind bears lac which is of great value. There could be a very large extension of lac cultivation on this plant which grows freely in very wide areas in India. On this tree especially there could be a very large production of lac on canal banks, on wastelands and wherever this tree occurs. Its potentialities as a lac producer equal that of ber and there is immense scope for rendering profitable lands that are now of little value except as a source of firewood and grazing for goats. Babul lac is apparently a distinct species and to start the cultivation one must obtain the mother-lac from babul. It is obtainable in Sind, Rajputana and the drier parts of North India (? also in the Eastern Ghauts), and is not known to occur elsewhere.

The Extension of Lac as an Agricultural Product.—The object of this article is to point out the possibilities of lac as an adjunct to the cultivation of crops and we may briefly indicate the steps to be taken in any locality to introduce lac and

PLATE XXIX.

A. J. I.

SCRAPING STICK-LAC.

commence cultivation. There are at present three methods of obtaining lac.—

(1). It is collected from certain trees which bear natural lac whenever the tree has a crop, a little being left on to serve as seed.

(2). It is systematically inoculated and collected from trees once a year, the trees being worked on the system described above for ber.

(3). It is cultivated on annual plants which bear only one crop and are then taken off. Arhar or tur is the most important example.

Where lac is found on pipal, banyan, siris, etc., it can be increased by spreading it to all the trees of that kind, by inoculating the trees, without previous pruning, from lac-bearing trees of the same kind. There is a very large field for extension of lac in this way and the only necessary thing is to ascertain for each locality what is the proper season for the inoculation, *i.e.*, the time at which the young emerge. Furthermore, a sufficient supply of lac to serve as seed should be left on when the crop is harvested to quickly cover the tree again. Trees which yield lac in this way include pipal, banyan, gular, pakur, babul, kikar or khair, siris, asan, and others of less importance. As the trees that bear lac like this vary immensely in different parts of India, one can only suggest that in every case, where lac is found on trees not pruned, that it should be spread to all the trees of that kind if possible.

The most important cultivated lac is that grown on the system described above on kusum (*Schleichera trijuga*), dhak or palas (*Butea frondosa*), ber (*Zizyphus jujuba*), babul (*Acacia arabica*), khair or kikar (*Acacia catechu*), and other trees. The trees used must be small enough to be pruned and handled and any lac-bearing tree that will stand this treatment will be suitable to this kind of cultivation. When any of these or other lac-bearing trees occur in wastelands, on bunds, along roads, scattered in the fields, along canal banks, by rivers and in nullahs, the lac suitable to that plant should be obtained and inoculated,

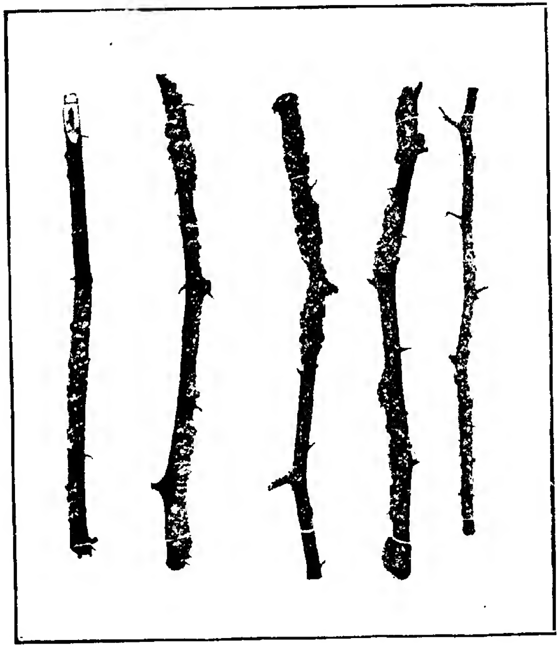
If only a few trees can be inoculated as a commencement, a start will be made. As a rule, lac will be found on enquiry to occur sporadically here and there and one has only to ascertain when the young emerge and then to utilise all the available lac for inoculation.

The field there is for extending lac cultivation in this way in India is immense and while it does not interfere with the yield of fuel from such trees or with the grazing of the land they are on, it makes an otherwise unproductive tree a source of profit, at a very small expenditure of labour twice a year. Lac cultivation on these lines was commenced in Behar in 1907. Lac is now being cultivated on otherwise unproductive trees in a number of factories and the entire outturn of seed is utilised in extending it ; it is only at the beginning now and we could advantageously use a hundred times the amount of available seed. This might apply to almost any agricultural tract in India, not necessarily with ber lac but with the trees and lacs locally procurable.

In this article, we desire only to draw attention to the advantages of lac cultivation in agricultural areas and, for so diversified a country as India, one article would not suffice to indicate the detailed steps to be taken in every district. The important points are to ascertain the available trees, whether lac occurs on them locally, the nearest source of lac, the season at which the young emerge (swarm). One must then prune or, if the tree grows too big, simply inoculate. When ber, kusum or dhak occur, then there is little difficulty; equally if figs occur. Mother-lac, if cut at the right time before the first young are out, will travel for some distance. We have sent it for 24 hours by rail and the original lac from the descendants of which the present Behar lac is being obtained, came from a long distance by road and rail.

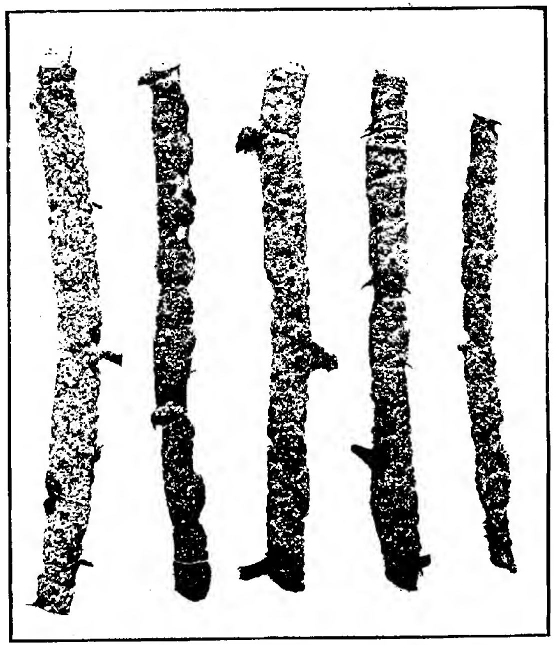
Lac of all sorts suffers from pests and enemies, and a few simple precautions may be taken. When the young insects are on the trees, ants come to them, not to feed on them but on the sweet excretion they give forth. It is said that the young

PLATE XXX.



A. J. I.

STICKS BADLY COVERED.
Fig. 1. Sticks of lac well inoculated.



STICKS WELL COVERED.
Fig. 2. Sticks of lac insufficiently inoculated.

insects suffer from these ants but it has never been proved that they do. As a rule, ants do no harm, but they may be kept off by strewing ashes round the foot of the trees or by painting a ring of tar or grease round the trunk of the tree low down. A much more serious enemy is the caterpillar which feeds in the lac incrustation. There are several species (*Eublemma* and *Hypatima*) which are found in lac on the tree and which continue to feed on the stick-lac after it is cut and brought in. There are others (*Ephestia*, etc.) which attack the dried stick-lac after it is harvested These are worst in the May-October crop, and occur far less in the cold weather crop. For that reason with ber, the trees inoculated in May are few, since there is no practical cure. There is one important point; as soon as the lac is cut or has been used for inoculation, scrape and wash it; otherwise the caterpillars will eat and spoil it. If stick-lac must be kept, then fumigation is the only remedy. But, it is always best to sell the lac as "seed-lac", *i.e.*, lac from which the dye has been removed by washing and which is in the form of small fragments. Lac-dye is now-a-days of so small value that we do not advise its separation unless there is a special demand for it. If large quantities of lac are being handled, extract it and sell it as dye or manure. But for a small home-industry, as we advocate lac cultivation, the lac-dye may be washed out.

Lac cultivation in the way we advocate here is being carried out at Pusa now and can be seen there. Instruction in pruning, inoculation, scraping, is given twice yearly when the work is being done on the estate. Those who wish to can come and learn or can send some one to learn. For those too far off, we shall be glad to give any help or information in our power and as trained men are available in some Provinces, those desirous of assistance or information should apply to the Agricultural Department of their Province. A limited amount of assistance can be given from Pusa with trained men. At the present price, lac is a remunerative industry; the present prices are the lowest for eight years and as there is a steady demand and a limited

source of supply, the price will remain at least where it is and probably advance. There is room for a very large cultivation of lac as a valuable crop in the agricultural areas of India; both where wastelands and trees are abundant and where there is a large population on densely cultivated areas as in Behar, the estimated value of the lac annually produced is near six crores of rupees and there is room for a very large extension of cultivation before the market will be lowered by overproduction.

The cost of growing lac in this way is so small, as compared with the cost of doing it in forest lands, that even at the present low prices, it is worth while for the agriculturist to whom it is only a minor industry; if the crop fails, the total loss is a few days' labour; if the price is low, as it is now, his expenses have been so small that he can still get a profit and the cultivation can go on independently of the fluctuating markets.

THE MANAGEMENT OF EXPERIMENT STATIONS IN INDIA.

By KHAN BAHADUR MIRZA ABDUL HOSAIN,

Moulmein.

THE *Agricultural Journal of India* (Vol. III, Part IV, for October 1908), contains an article on the "Management of Experiment Stations in India," by Mr. B. P. Standen, C.I.E., I.C.S., Director of Agriculture, Central Provinces; and in a foot-note the Editor invites criticism on it. As a private agriculturist I wish to offer some remarks on the subject.

Mr. Standen begins by stating "that the object of an Experimental Station is not to make a profit, but to solve certain problems of sufficient importance to warrant the expenditure of public money." He then goes on to say "that the area allotted is too large (about 200 acres), and so much money is spent on good buildings and cattle that the stations do not pay. The first thing which strikes a cultivator who visits a station fitted in this way is the enormous cost of the arrangements. He at once draws the conclusion that if the crops are better than he can raise, it is due to lavish expenditure beyond his means. He sometimes doubts whether even the fine crops which he sees on the ground will pay for the expenditure which he incurs, and if he asks for information, he is told that there is a large loss on the station, and that it is not intended that it should pay. This sends him away with a very natural, though a wrong idea of the value of the work that is being done."

I consider the writer is inconsistent. If the object of an Experiment Station be what he says, then no reasonable expenditure by the Agricultural Department should be spared in

solving problems of agricultural importance to the country. The Agricultural Department in India has been established for the purpose.

Mr. Standen apparently compares the costly buildings for men, cattle, stores, machinery, implements, etc., with the buildings on ordinary cultivators' holdings. I admit that the buildings on some Government farms are much too costly, but if the work on these farms is to be carried on by men of any education (European or Native), how would it do to house such men in dirty hovels and to let them work with wretched cattle and antiquated appliances as used by native cultivators? Moreover, is it not likely that the existence of better buildings and plant on these Experimental Farms will induce the native cultivators, at least those of them who can afford to do so, to improve their farmsteads?

Mr. Standen then states that the first thing that strikes a cultivator who visits a Government Farm is its enormous cost, and the cultivator draws the conclusion that if the crops are better than his own, they are due to high expenditure which he cannot afford. He is told on enquiry that they do not pay; whereupon he goes away disappointed. I should like to ask Mr. Standen if any cultivator has attributed the excellence of his Government crops to the existence of the costly buildings there. If so, why has this error not been corrected? The native cultivator really need not ask for an opinion on this point. He has the practical knowledge to know that the crops are good not because a costly building is standing by.

Why should he be told that the crops on the station do not pay, in order to go away disappointed? He should be told that money is spent on experiments the results of which may be for his benefit in order that he may take continued interest in the work of the Station.

Further, Mr. Standen states—" It must be recognised that agriculture cannot give the same returns in India as in Europe, *because cattle are not kept for food* (the italics are mine), and the quantity of farmyard manure available must be much less

and is as a matter of fact extremely limited." I think this statement is a little exaggerated, for, I believe, farmyard manure can be made available in large quantities in almost all parts of India, if some care is taken for its storing. If in the Central Provinces farmyard manure is not available in large quantities, it is probably due to the fact that it is made into cowdung cakes and sold for fuel.

I would like to point out that every experiment should at first be on a small scale. If successful, then it should be extended on a considerable area to see if it will pay from a commercial point of view.

The statement with which Mr. Standen starts is true, namely, that the object of an Experimental Farm is not, and should not be, to make a profit. It should be to evolve methods for the improvement of Indian agriculture. Many experiments may fail and much money may thereby be wasted. This is inevitable.

In my opinion the whole question comes to this—is the agricultural condition of India perfect or not? If it is perfect, then abolish the Agricultural Department and close the Experimental Farms. If it is not perfect and if there is room for improvement in agriculture and in the material prosperity of the country, then the yearly expenditure on the Experimental Stations—provided the money is judiciously spent—need not be seriously considered. I think, it is unfortunate that Mr. Standen should have written as he has, at the present moment, when the Agricultural Department is still in its infancy and when we expect great results from its researches.

HEART DAMAGE OF BALED JUTE.*

By R. S. FINLOW, B.SC., F.C.S.,

Fibre Expert to the Government of E. B. and Assam.

THE more recent work on which the above report is based arose out of a correspondence between Messrs. Cross and Bevan and the writer of this review on the subject of the natural moisture content of jute fibre. In July 1907 an arrangement was made for collaboration in an investigation into the causes and possible methods of prevention of "Heart Damage" in jute, on account of which 3 per cent. of the total imports of jute into Dundee in 1906 was said to have been rejected.

Points dealt with in the report.

For practical purposes, the report may be divided into the following sections:—

(*a*) A technical description, with analytical figures, of the change which takes place when jute undergoes "Heart Damage."

(*b*) A description of the condition, on its arrival in London, of jute treated and baled in India by the Fibre Expert to the Government of Eastern Bengal and Assam.

(*c*) Recommendations.

Taking these sections in order, we find that "Heart Damage"†

Description of "Heart Damage"

is a deterioration of jute involving a radical alteration in its properties, both physical and chemical. Physically, instead of remaining a fibre of considerable tensile strength, it becomes a spongy brittle mass, which can

Changes produced by "Heart Damage."

easily be rubbed into a fibrous powder. "Heart Damage" jute is therefore entirely useless for

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* Report to His Majesty's Secretary of State for India by Messrs. Cross & Bevan, on investigations of jute fibre in relation to "Heart Damage" of baled jute.

† So called because the effects of the deterioration appear first in the centre of the bale of jute.

spinning purposes. The chemical change produced is equally great, the most important characteristics being—

(1) Great diminution of cellulose content.

(2) A far larger proportion of the weight of the fibre becomes soluble in water or in simple chemical reagents.

(3) Diminution of the yield of furfurol in the distillate obtained on boiling the fibre with Hydrochloric Acid.

These changes, which may be taken as typical, to some extent, of organic decay, are summarized in the following table :—

	(a) Normal fibre.	(b) Damaged fibre of same bale.
Moisture	10·7	9·8%
Ash	1·2	1·3
Constituents soluble in water	1·1	11·5%
Soluble on boiling with 1% caustic soda for 5 minutes	11·0	23·3%
Ditto ditto for 60 minutes	14·0	58·3%
Furfurol (total)	7·8	5·8%
Phloroglucol absorption	4·2	8·0%
Chlorination reaction	8·9	10·2%
Cellulose after dissolving the chlorinated derivative	75·0	62·6%

Diminution of cellulose.

A heart damaged sample of jute examined by the writer showed an even lower figure for cellulose than that quoted above, and the proportion of soluble constituents was also correspondingly higher. The cellulose content of a fibre is probably the most important criterion of its durability and the great diminution of so important a constituent shows the deep-seated nature of the deterioration.

Increased proportion of soluble constituents.

The increased proportion of soluble constituents is only to be expected; but it is worthy of notice that nearly one half of the soluble matter consisted of, or was easily resolved into, sugar-like bodies, a fact which indicates hydrolytic distintegration of the cellulose constituents.

Diminished furfurol yield.

The conclusion to be drawn from the diminution of furfurol is not quite certain; but it is possibly a sign of deoxidation, which would be an indication of anærobic fermentation.

The microscopic aspect of the change indicates that it is similar to that produced by strong hydrolysing acids, *i.e.*, the fibre bundles are attacked integrally rather than resolved into their constituent ultimate fibres. The disintegration was not produced by moulds, because in no case was it found that the mycelia of the mould growths present had penetrated the fibre bundles.

Microscopic effect produced.

One of the conditions necessary for the development of "Heart Damage" is moisture. When the investigation was first taken up, it was thought that "Heart Damage" could be produced with less water than now appears to be the case. Consequently in the baling experiments dealt with in the report the amount of water added was only sufficient to bring the total water-content up to rather less than thirty per cent. The experiments were devised to obtain the following results :—

Conditions necessary for the production of "Heart Damage."

Baling experiments

(1) To produce "Heart Damage."

(2) To see if the presence of easily fermentable matter such as sugar would tend to hasten the deterioration.

Objects of baling experiments.

(3) To see whether "Heart Damage" could be prevented by addition of a small quantity of an antiseptic to the fibre.

On being opened in London, about three months after making up, none of the six bales showed any obvious sign of deterioration and the contents were sold in London as high class fibre. Thus, none of the objects aimed at in the experiments were obtained, because, having failed to induce "Heart Damage," the effect of antiseptics in inhibiting its progress could not be gauged.

Result of baling experiments.

Samples from each of the bales were incubated aerobically for forty days at 35°C. ; but, as was to be expected, no results were obtained, beyond strengthening the probability that "Heart Damage" takes place under conditions which are not aerobic. The baling experiments are regarded as tentatively justifying the following conclusions.

Conclusions from results of baling experiments.

(1) That the presence, in clean baled jute, of nearly 30 per cent. of water does not cause any evident damage even after many weeks.

(2) Even the presence of easily fermentable matter together with this amount of water is not necessarily harmful.

(3) Mould and aerobic bacterial growth may develop on the fibre without causing deep-seated changes therein.

(4) Formaldehyde appears to have a more powerful preservative effect on jute than corrosive sublimate, both substances being used in solutions of the usual strength.

Attention is called to the fact that the phenomenon of "Heart Damage," resulting, as it appears to do, in the production of nutrient matter available for living organisms, though undesirable in the case of jute, might become a most desirable process, under control, for the utilization of lignified waste or by-products such as sawdust, etc.

Recommendations.

In recommending the continuance of the investigation, Messrs. Cross and Bevan advise that a series of experiments be carried out on a practical and commercial scale, comprising the addition of 7 to 14 lbs. of formalin per ton of baled jute. This advice is based on two assumptions :—

(*a*) That the cause of "Heart Damage" in jute is biological and that it can therefore be prevented by treatment of the jute with an antiseptic before baling.

(*b*) On the fact that a sample from one of the formalin treated bales sent to London showed an apparently greater resistance to alkaline hydrolysis than the contents of other bales.

Such experiments must be premature until the cause of "Heart Damage" has been elucidated. However probable it may be, it has, as yet, by no means been proved that the deterioration is due to bacterial agency. Moreover, it is not yet certain that the deterioration, when it takes place in baled jute, is not avoidable even without treatment with antiseptics. The second reason advanced for the proposed experiments is based on evidence which requires considerable confirmation before it could

justify the expenditure contemplated by Messrs. Cross and Bevan. It will, however, be quite easy to test the effect of formalin on jute in the laboratory.

Proposed organization in England for the investigation of "Heart Damage."

In a later communication than the report before us, Messrs. Cross and Bevan also propose an elaborate scheme which would undoubtedly prove very expensive, for the investigation in England of "Heart Damage." In view of the fact of the existence of the Indian Agricultural Department which is now fully equipped to undertake the Scientific side of such an investigation as the one in question, an organization in England to investigate "Heart Damage" seems superfluous: it should be remembered, too, that the raw material is available in India in any quantity and at cost price, also that it can be produced under conditions which can be varied at will. There is moreover in India, as in England, a large commercial community, which is willing to assist, as far as possible, in the solution of problems affecting its interest.

Ability of the Indian Agricultural Department to undertake such investigation.

Results already obtained in India.

It may be said in this connection that typical heart damaged jute has already been produced at Pusa under fairly well defined laboratory conditions, and that some further progress has been made towards the elucidation of the causes of the deterioration.

The first part of Messrs. Cross and Bevan's report constitutes a valuable scientific essay on the general characteristics of "Heart Damage" in jute; but the recommendations at the end would appear to be somewhat premature until the causes of the deterioration have been carefully worked out in the laboratory.

RICE CULTIVATION IN LOW-LYING LAND IN BURMA.

By KHAN BAHADUR MIRZA ABDUL HOSAIN,

Moulmein.

THERE are extensive tracts of low land in Lower Burma which are lying waste owing to their being inundated during the latter portion of the rainy season, in August and September. In some places the water rises four or five feet high. When the water subsides, sowing or transplanting cannot be done as the rains cease in the beginning of October; nor are these tracts fit for cold weather cultivation because such crops do not get the few necessary showers.

It appeared to me that the method of cultivation in vogue amongst the Burmans was faulty, and that by altering the method, it might be possible to combat the floods successfully.

The method practised by the Burmese in this district is to begin ploughing after the rains have well set in and the land becomes soft. Sowing or transplanting is done generally in July. In August—the month of the floods—the paddy plants are only about two feet high, and when submerged for a few days, they perish.

It occurred to me that if the ploughing could be done in the dry weather, and the sowing before or immediately after the setting in of the rains, at least two months would be gained, and the plants might be tall enough in August to resist or survive the floods. But two difficulties were suggested against this change. First, that land could not be ploughed, and, secondly, if the sowing were early, the crops would mature correspondingly earlier, *i.e.*, before the rainy season was over and that, therefore,

reaping and threshing would be practically impossible while the rainy season continued.

It became also clear to me that the country ploughs could not plough dry land, but it might be possible to overcome this difficulty by other appliances or improved ploughs; besides, if the plants got into ear correspondingly earlier, the continuance of the rains would retard their maturity and thus make the grain fuller and richer.

I accordingly decided to make an experiment. I imported a few English ploughs from Messrs. Ransomes, Sims and Jefferies, of Ipswich, and began ploughing in January. For the first three or four days it was uphill work, and my men regarded the use of the ploughs as hopeless. After some perseverance the men learnt to handle them. These ploughs did good work when yoked each to two buffaloes. My men have since discarded country ploughs in favour of Ransomes' English ploughs both for dry and wet weather ploughing. The kinds marked E. C. and S. R. A. W. in Ransomes' catalogue are most in favour, though we use some of the smaller kinds for lighter work.

Having finished ploughing, I began sowing. For broadcasting the Burman soaks the seed two or three days to sprout. The practice, though all right when water is standing in the fields, appeared to me to be open to two objections. In the first place, if by the time the seed has sprouted there should be a break in the rains, the sprouted seed cannot be held back, and if broadcasted, would be liable to perish. In the second place, the sprouted seed is liable to be injured by handling. I therefore decided to try new methods—new at least to this district. The first was to broadcast dry seed on dry land and then to give the land light ploughing to cover up the seeds.

The second was to raise the seedlings by irrigation before the rains commenced, and to transplant them immediately after the rains set in. Both these methods succeeded exceedingly well. By the month of August when water rose to five feet in the land the paddy plants were six feet high, and so were not submerged and survived the floods. Furthermore, the plants

were reaped when ripe about the same time as the later sowing on other fields.

The kinds that grew best were *Yehini* and *Shangley*. The qualities of both were as superior as those grown on ordinary paddy lands. These experiments have been under successful trial for three years.

It has thus been demonstrated that on low-lying lands, where floods do not permit of good paddy being grown according to the ordinary methods, it can be grown successfully if cultivated earlier than usual.

Besides there was an advantage in ploughing land during the dry season. A plot of land which in previous years when ploughed during the rains produced poor crops and was looked upon as poor land.

This area yielded excellent crops when ploughed in the dry weather. This proved the advantages of dry weather ploughing and exposing ploughed land to the sun.

This method of dry weather ploughing is being adopted by some of my neighbours who now see that under certain circumstances, a departure from old methods is conducive to improved cultivation.

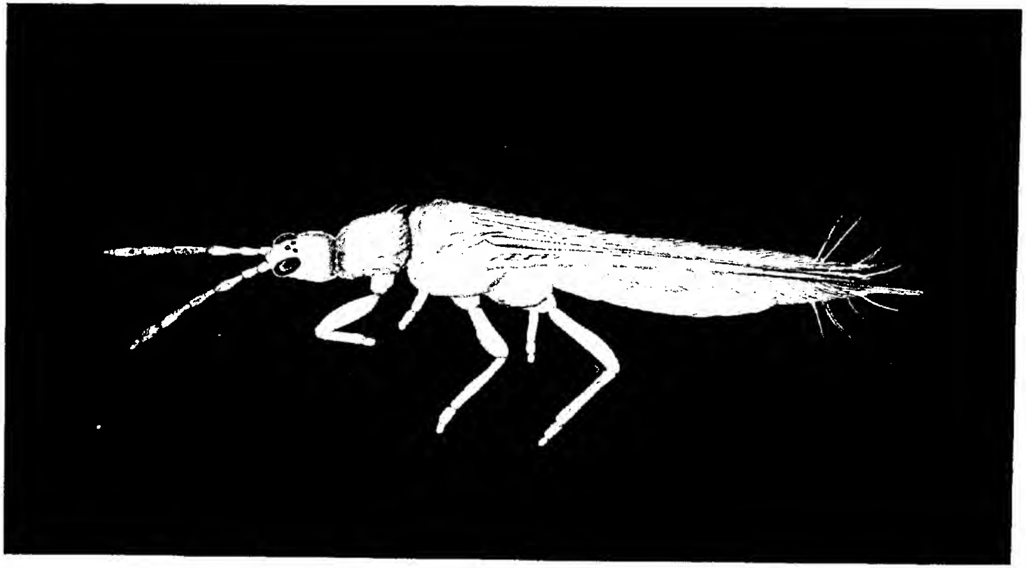
For low-lying lands there is, of course, the water-resisting paddy known by the Burmese names of Todaungbo or Yemanaing which for the last two years has been making headway in this district; but the grain does not find favour with the millers.

NOTES.

THRIPS IN TEA.—Thrips is a small insect which is found upon tea bushes and is associated with a diminished yield of leaf, due to the shoots not growing. The full grown insect is about 1/15th of an inch long, the colour brown or black, the body slender, with two pairs of narrow wings fringed with long hair. It is found on the shoots, upon the upper surface of the young leaves or buds, frequently in the opening leaf while it is still curled. It runs actively about and may be easily seen if the shoots are examined. The young are like the full-grown insect, except that they are wingless, of a yellow or red colour and more fragile. They are found with the adults in or on the shoots; the quite young ones are almost white, very small and delicate, found on the very young leaves or in the curled leaf, They hatch from eggs laid in the soft tissues of the leaf or shoot. There is one kind of Thrips abundant on tea and others found more rarely: the damage is practically all done by two species. The most important points are that the young are like the adult (*i.e.*, there is no grub or caterpillar stage) and that the living insects are found on the shoots throughout their active life. (Plate XXXI.)

Thrips injure the shoots by scraping at the leaf, destroying the epidermis and projecting veins, weakening the leaf and interfering with its nutrition. The leaf becomes brittle, loses its fresh green colour, and the whole shoot ceases to grow. The leaf and shoot do not normally die, but simply become unhealthy and remain stunted. The damage done by Thrips is totally distinct from that done by such insects as Green-fly or Aphis, which bury their beaks in the tissues, cause only a small puncture and suck out the juice from inside. Thrips cannot do that, but rasp

PLATE XXXI.



A. J. J.

THRIPS IN TEA. × 40.

the leaf, destroying the surface tissues. Thrips also feed on pollen and they live normally in flowers. It is said that tea made from thrippy leaf is devoid of flavour; that opinion is not endorsed by all planters, and the experience at Phoobsering is that there is no loss of flavour, but a very heavy loss in weight of leaf plucked.

It is impossible now to account for the increase and abundance of Thrips on tea in the Darjeeling District. It has probably been on tea since tea was first planted. It is also likely that the damage it has caused has frequently been confused with that caused by Green-fly or other pests. It is extremely likely that past dry seasons have caused it to increase either directly by being favourable to it or indirectly by producing abundant blossom. I believe it is accurate to say that in dry weather the Thrips flourishes, that normally during the rains it is more or less inactive, and that its most active season is when there is fine dry weather and perhaps plenty of blossom. Normally in wet weather the Thrips is very much hampered by the wet leaf, the finer leaves often holding drops of water, and it is far less active in cloudy cool weather than under bright sunshine. Equally it is less abundant and destructive under shade. When we consider that the insect spends its life on the small leaves, we can believe that the constant wetting of these leaves checks the activities of the insect, and that it thrives in dry weather. Whatever may have caused it to increase, it has been abundant and has caused damage There is the greatest diversity of opinion among planters as to when it was first noticed, but there is a general agreement among those who answered my circular that the loss is about a half to one maund of tea per acre on the affected blocks. Most planters report damage during 1908, and principally at high elevations; the China *jat* and poor *jats* of hybrid are attacked far more than good *jats*.

Treatment.—No special precautionary measures are possible against Thrips, except such commonsense ones as depend upon keeping up the vigour of the plant; it is not associated with any other plant, wild or otherwise, which can be destroyed;

mechanical methods of catching it on a large scale do not seem feasible ; it must be destroyed upon the shoot, and this can be done only by means of insecticides applied to the bushes ; dry insecticides, such as sulphur, are of no avail, as none is known that will destroy the insect ; and the only possible method of destroying it is to spray it with a liquid contact poison. From the replies received it is evident that no treatment has been tried on a large scale, though on some gardens experiments have been made.

During the course of experiments at Phoobsering, various contact poisons were tried ; such insecticides as soap, oil-emulsions and rosin solutions are all effective at the proper strength, and the problem is simply to find the one which at the necessary strength is the cheapest. Crude oil-emulsion, soap, and rosin compound were all tested carefully, and for each one separately the equivalent strength required was ascertained by spraying bushes with weak and gradually stronger solutions, collecting after each spraying a number of leaves with Thrips on and watching these till the Thrips either died or recovered ; if the Thrips recovered, the solution was made stronger till the effective strength was found. On working out the cost of these various solutions, it was found that rosin compound was the cheapest. The relative cost of crude oil-emulsion, soap and rosin compound at equivalent strengths is Rs. 5, Rs. 4, Rs. 2-8 respectively, the first alone requiring no fuel for heating. Rosin compound has also the advantage of being an insecticide that "wets" extremely well, that dries rapidly, forming a varnish of rosin over the bud or leaf, and that penetrates extremely well into a curled-up leaf. That rosin compound is effective has been ascertained in several ways ; observation of Thrips on sprayed bushes shows that, if wetted, they do not recover on being dried or if not dried ; with weak strengths of these insecticides the Thrips may be wetted but recover on drying ; observation and counting of Thrips on the bushes show that with ordinary spraying a very high percentage of the Thrips actually on the bushes are wetted ; it would be impossible to spray every one simply

because with ordinary work it is impossible to be sure that every shoot is sprayed; (it has also been found that actually almost every sprayed Thrips is washed off the bush; this must be remembered as after spraying one finds very few dead Thrips on the bushes though many have been killed, and total number is very much reduced). Lastly, the improved appearance of the sprayed bushes, as compared with unsprayed bushes, is very marked; we have sprayed blocks of tea, leaving neighbouring blocks unspread, and the improvement in the appearance of these blocks, after a week or fortnight, has been extremely marked. It must be remembered that not only does the wash kill the insect, but by varnishing the leaf it prevents the insects feeding till the rosin flakes or washes off. In this way the best treatment for Thrips has been extremely carefully worked out at Phoobsering, and I believe that the most practical method of checking Thrips is to spray with rosin compound; no other remedy equally practicable or cheap has been found, and this appears to be the best and simplest treatment. I rely almost entirely on the appearance of sprayed bushes, as compared with unsprayed ones, in concluding that this method really does lessen the number of Thrips; we know that Thrips, sprayed with this insecticide, is killed; but it is not possible in practice to actually estimate the number killed per bush, the percentage killed or the real direct effect, chiefly because of the very small size and the activity of the insect.

Cost of the Treatment.—Rosin compound is prepared in this way: a gallon of water is warmed and a pound of soda dissolved in it; it is then boiled and two pounds of powdered rosin added; boiling is continued, while cold water is added slowly till the whole amounts to four gallons; during this boiling the liquid from being thick and soapy, becomes a clear brown, thin and not soapy; it is then ready and taken off the fire. This mixture (stock solution) is then diluted with water for spraying at the rate of 7 pints to 3½ gallons, *i.e.*, 7 pints are put into a four gallon tin or spraying machine, and the tin filled up with water to almost the top. I tried using it at 4, 5 and 6 pints to

the machine full of water ; at 6 pints it kills Thrips ; at 5 and 4, it kills only some ; I believe 7 to be a strength at which all Thrips will, with absolute certainty, be killed if wetted.

Spraying is done with ordinary Knapsack Spraying Machines, the spray being directed to the *tips of the shoots* so as to reach the Thrips there. Success Knapsack sprayers made by the Deming Co. with their Bordeaux nozzles have been used and are recommended, but any machine giving a fine enough spray may be used.

The amount of wash used per acre varies up to 130 gallons for well-grown bushes ; we filled the machine 36 times, *i.e.*, 36 times 7 pints of stock solution were used, or 31½ gallons. Four gallons of stock solution contain 2lbs. of rosin and 1lb. of soda, so that 32 gallons require 16lbs. of rosin and 8lbs. of soda. The amount used per acre is thus 16lbs. of rosin and 8lbs. of soda on the average ; soda costs Rs. 7 per cwt. or 1 anna per lb. Rosin not more than double that ; the total cost per acre for materials is then Rs. 2 for rosin, and annas 8 for soda, total Rs. 2-8. If mono-hydrated soda is used, costing Rs. 7 per cwt., 11 oz. should be used, reducing the cost of soda to about 5½ annas ; with labour the average cost comes to about Rs. 3 per acre for each spraying.

In actual working we found that, having two men to each machine carrying and spraying alternately, an acre could be done daily. Experienced men will do more, and it is not always necessary to have two men to each machine, since one man can do the whole thing ; it is better as the work on sloping blocks is tiring and by changing each time the machine is filled, the men work more rapidly, there are also required men or boys to bring water, etc. We have found that two men with one machine do one acre daily, each two machines requiring one man to bring water (the latter varying, of course, with the place). Ten machines with 25 men can ordinarily do 60 acres per week, the amount varying with the distance from which water must be brought, the size of the bushes and the efficiency of the arrangement. We have actually found this figure easily worked up to in practice.

One item also must be added, and that is, labour and fuel for boiling the stock solution; for each acre, 32 gallons must be boiled. Initial requirements for 60 acres per week will be :—

Ten machines at Rs. 50. Five barrels or other vessels to hold stock solution and water. Four 5-gallon drums or other vessels to boil up to 20 gallons of stock solution at one time. (If available, a large vessel holding 20 or more gallons at a time would be best.)

The spraying is done by marking out the block and working along the lines from one side, each machine having four or eight lines marked for it: the men do two lines of bushes at a time and walk up one row, down the next row but one, so returning each time to the side having done four rows: they then take the next unoccupied four rows, and the whole number of machines gradually work down the block, the barrel in which water is collected and the stock solution moving along from time to time so as to be close at hand.

The spraying machine recommended, which I believe to be the best, is a Knapsack one, *i.e.*, one carried on the shoulders, with a small force pump worked by a lever over the shoulder, a reservoir holding four gallons, a $\frac{3}{8}$th inch rubber tube 5 feet long and a brass spray nozzle adjustable to give a fine spray or to close. There are no rubber parts to get out of order except the tube, which is easily renewable, but which ordinarily lasts for several years: the only part eequiring adjustment is the packing at the top of the cylinder which is easily got at and repacked. If too much pressure is got up, *e.g.*, by the man pumping when the nozzle is closed, the rubber tube may be blown off the pump, but it is easily put back. After spraying is finished, if the pumps are not to be used for some time, they must be washed out with clean water pumped through the machine, or the rosin dries and fixes the position. These pumps are equal to any other kind available, and there is a stock now available in India. The pumps last for years, the rubber tubing alone being perishable. They cost from Rs. 40 to Rs. 50, depending on the reservoir being galvanized or copper.

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The rosin used is ordinary fir-tree rosin, obtainable in India at prices varying from Rs. 6 to Rs. 10 per maund. Our rosin cost Rs. 12-9-0 per cwt. landed in Darjeeling and mono-hydrated soda Rs. 9-13-0 per cwt. The soda used is ordinary crystal soda (washing soda); if it is wet or impure, more than a pound must be used, or the stock solution will not boil clear, and this can only be found by adding a little more if the stock solution after being boiled and gradually brought up to four gallons will not come clear. If mono-hydrated soda is used, then a less quantity is required as it contains a greater proportion of soda, and we have found 11 oz. to two pounds of rosin enough. The soda need not be pounded as it dissolves readily, but the rosin should be in particles not larger than coarse sand. The mixture is not poisonous, and if properly made, the stock solution will keep indefinitely. It cannot be bought ready made except at an extravagant price. In filling the machine, 7 pints of stock solution are poured in, always through the strainer, and the machine is then filled up with water; the stock solution must be put in first so as to get well mixed.

There are small points regarding machines, method of work, etc., which are best learnt by seeing the work actually in progress. The nozzles require adjusting at first to a fixed point, so as to give the right spray, as the men do not at first understand them. If an automatic nozzle is required, then the Vermoral should be ordered. I believe that this method is thoroughly efficacious, that it can be carried out with very little difficulty on any tea estate, and that if done thoroughly, Thrips can be thoroughly checked; with one spraying the Thrips will be so reduced that it will not be destructive for that season; with two at an interval of a week to a fortnight, almost every Thrips will be killed; absolute extermination is impossible.

Thrips spread slowly and does not fly long distances; infection from neighbouring unsprayed blocks will, I believe, occur slowly, and it seems certain that it will be profitable even only to spray the worst blocks; it will be more profitable to spray large blocks throughout, and the effect will be more lasting.

The best time to spray is at the commencement of a flush before the new leaves are too large, but the spraying can be done at any time when the weather is not actually wet. It is useless doing it in wet weather, but so long as it is not actually raining, and there is time for the liquid to dry, say two hours, then spraying will be effective. I am not able to say at what time of the year spraying is best done; we have done all our spraying in April-May and September-October. If a block of tea is thrippy, spray at the first opportunity. Later on when we have had more experience, we can decide, if there is one season better than another, and whether it will pay to spray the whole garden; for the present I would advise spraying first the worst pieces and seeing that the results justify.

Mr. Irwin has suggested that the treatment must be varied according to the condition of the bushes. The new growth made from pruned tea in the first season is of so much importance that it will pay to spray such tea twice to ensure a complete eradication of thrips and to secure a thoroughly good growth during the first year. With unpruned tea, the damage done by Thrips is temporary and not permanent, and a single spraying, done whenever required, will probably be sufficient. We are working on these lines, spraying the pruned tea twice, so as to make perfectly certain of a good growth throughout the season.

It is probably best to spray pruned tea as early as possible, at the beginning of the first flush if Thrips is active with a second spraying between the two first flushes or doing both sprayings after the first flush. It may be dangerous to do the first spraying too soon as the thrips must be active on the young shoots if the spraying is to be effective. As far as possible all spraying is probably best done in the interval between the first two flushes when the labour is available and there is usually a spell of fine weather. From the 7th May to the 15th June seems to be the time at which the work can be done in the Darjeeling district; this applies particularly to pruned tea, but it will be better to spray unpruned tea also at this time if it is thrippy and if it can be done.

Sprayed leaf has been plucked and manufactured within one week after spraying, and the flavour has not been altered. It is apparently perfectly safe to spray up to within one week of plucking with no effect on flavour, and it is probable that the safe period is less than one week. Either there is nothing in the rosin-soda compound that effects flavour, or it is washed or flaked off within a few days, or else it is all removed from the leaf during manufacture. (H. M. LEFROY.)

* * *

CULTIVATION OF BROACH COTTON AT DHARWAR.—The climatic and rain conditions being favourable, Broach cotton is grown very successfully for the last two or three years round Dharwar. Broach cotton is sown two months earlier than the Kumpta variety as its period of growth is two months longer. Thus both ripen at the same time in March and April.

Broach cotton is sown before the *Aridra* rains cease, about the 10th July, to avoid damage by ante-monsoon rains. In sowing, the seed should be prepared like that of the Kumpta variety by applying mud and rubbing the same to allow the seed to pass freely through the tubes. An acre requires about 7 to 8lbs. of seed. The seed should be sown in rows of 2 feet apart.

The crop requires land which has been well manured and cultivated. Weeding, interculturing and other cultivating operations for this crop are like those of Kumpta variety.

The plants when six inches high should be thinned to 1 foot apart in the rows. In thinning, weak plants should be removed. When 1 foot or more high, the plants should be nipped off $\frac{1}{2}$ inch from the top.

One *Kurgi* (4 acres) yields on an average seed cotton of about 96 maunds. Last year on the Dharwar Government Farm one naga (48 mds.) seed cotton yielded about 16½ to 17 mds. of lint.

To get the highest percentage of lint, Government have obtained from Navsari 25,000lbs. of pure Broach cotton seed, and arrangements have been made at the Government seed depôt at Dharwar to sell the seed to the cultivators at 32 lbs. per rupee.

Last year, to enable the cultivators to obtain fair prices for their cotton, Government opened a central market where all cotton grown near Dharwar was collected and sold by auction. Merchants from Bombay, Ahmedabad, Dharwar, Hubli and Gadag attended the auction sale. The price was Rs. 156 per naga (48 mds.), while Kumpta variety was sold at Rs. 115 per naga (48 mds.).

The last sale of Broach cotton took place at Dharwar on 25th April last. The Agricultural Department offered prizes to cultivators who grew the best crops of Broach cotton, and thereby excited keen emulation. The actual quantity of kapas, collected at the sale, was 336 nagas of 1,344lbs. Buyers from Bombay turned up in force and the bidding was lively. This year the Agricultural Department classified all cotton according to its ginning percentage. The price realised for each class was, on the whole, in proportion to the ginning percentage. The class ginning from 30 per cent. to 31 per cent. fetched Rs. 150 per naga, and the highest class ginning above 35 per cent. was sold for Rs. 176 per naga. The lowest class which was probably a mixture of Kumpta and Broach and was ginning below 30 per cent. fetched Rs. 135 per naga. Out of the total quantity of 336 nagas, less than 17 nagas sold below Rs. 150. The average price for Kumpta cotton was Rs. 116 per naga at Hubli on the day of sale. The auction was witnessed by over 200 cultivators who had this year grown Broach cotton. (EDITOR.)

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NON-NITRIFYING SOILS.—It is generally taken for granted that all fertile soils have the power to convert organic and ammoniacal nitrogen into nitrate nitrogen, *i.e.*, to nitrify. Recent work at the North Carolina Experiment Station appears to prove otherwise. (See Note by F. L. Stevens and W. A. Withers in *Science*, dated March 26, 1909.)

Out of 62 samples of local soils only 29% nitrified, while 71% failed to do so under laboratory conditions.

The soil tests were made by adding nitrogenous material, organic or ammoniacal to the live soil, or by sterilizing the soil,

adding the nitrogen, then inoculating with a suspension of the soil to be tested. The soils reported as giving a negative result did not yield enough nitrate to respond to the very delicate diphenylamine test. A large proportion of those that showed nitrification had only a very minute quantity of nitrate.

Rich soils from other districts were found to give positive results. It must, therefore, be recognized as a bacteriological possibility that soils may be devoid of nitrifying power. When we consider our existing beliefs about soil fertility, it is difficult to gauge the significance of the above observations.—(W. ROBERTS.)

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* *

PEAT.—Last year Mr. T. N. Sivanantham Pillay, Ootacamund, sent to the Inspector-General of Agriculture for analysis two samples of peat and peat moss from a big area of peat bog in his estate. These samples were analysed at Pusa. The chemical analysis of each is as follows :—

	Peat.	Peat moss.
Moisture	10·69	10·39
Organic matter ...	70·10	59·68
Soluble mineral matter	6·72	9·35
Sand	12·49	20·58
	100·00	100·00
Nitrogen	1·57	1·34
Phosphoric acid	18	·21
Lime	·15	trace.
Magnesia	·13	·20
Potash	·16	1·76

Dr. Leather reports that the amount of potash in the peat moss is high and that the amount of nitrogen is about usual in each sample.

As peat is usually very inert when used as a manure, Dr. Leather tested the manurial value of these samples as follows. They were mixed with damp earth in order to ascertain the rate of formation of nitrates. A comparison was made between the peat and peat moss and unmanured soil and with soil mixed : (*a*) with castor cake ; (*b*) with farmyard manure ; and (*c*) with leaf mould.

The soils were maintained with 15% moisture for 57 days and then analysed. The results were as follows :—

			Parts nitric nitrogen per million of soil.
1.	Soil only ...	50lbs. of nitrogen per acre.	23
2.	Castor cake ...		31
3.	Leaf mould ...		23
4.	Farm manure ...		35
5.	Peat ...		14
6.	Peat moss ...		31
7.	Castor cake ...	250lbs. of nitrogen per acre.	84
8.	Farm manure ...		21
9.	Peat ...		29
10.	Peat moss ...		31

The analyses do not show very definite results regarding the availability of the nitrogen in the manures used.

During the coming monsoon a pot-culture test will be made at Pusa to test the value of the peats in comparison with other manures.

In no country is peat or peat moss used to any extent as manure. Peat is, however, used largely as an extremely useful litter in horse stables, cattle byres and poultry houses. This litter is much more absorptive than ordinary litter and, therefore, keeps the stables, byres and poultry houses in good sanitary condition. The resulting manure is generally considered excellent for ordinary farm crops and in horticulture.

For easy and cheap transport the peat and peat moss should in air-dry condition be baled like hay. The binding material used in England is generally thin flexible wire with thin strips of wood on two opposite sides of each bale to prevent the wire cutting into the peat.

Peat or peat moss will in India probably be found useful as a packing material in transporting by road or rail the more delicate fruits, such as peaches, mangoes, grapes, etc. Such fruits can only be transported to considerable distances or stored for some time, if very carefully packed.

Peat in the form of a powder is now used in England as a packing material for apples and other fruits that have to

be kept for months. The packed fruit is stored in ventilated boxes.

The usefulness of peat for this purpose is being tested at Pusa. The peat bog from which the samples of peat and peat moss were obtained can supply a very large output annually.

Peat is known to exist in India not only in the Nilgiris, but also in Assam in very large quantity.

The approximate cost of baled dried peat free on rail should be as follows from Ootacamund :—

PEAT MOSS IN WAGON LOADS.

			Per cwt.
1.	Peat moss (pressed and baled)	...	Rs. 1 8 0
	Peat (do. do).	...	" 0 12 0

FOR LESS QUANTITIES.

2.	Peat moss (pressed and baled)	...	Rs. 2 0 0
	Peat (do. do.)	...	" 1 0 0

(EDITOR.)

* * *

SPINELESS CACTUS.—Some of the Spineless *Opuntias* are grown in India as garden curiosities.

"The Genus *Opuntia* belongs to the American Continent and the West Indies. A considerable number of species, however, have now become naturalised in many other parts of the world."

"The fruits of *Opuntia*, or at least some of them, are edible, and to some palates they are very agreeable. Sir J. Hooker compares them to pumpkins."

O. Ficus indica is a native of Central America whence it gradually spread all over the world. It is cultivated for its fruits, which are sometimes used as dessert fruits.

The fruits of *O. brasiliensis*, *O. decumana* and *O. rafinesquii* (which is spineless) are also good to eat.

The fruits of the common prickly pear, *O. dillenii* and *O. nigricans*, are eaten by poor people in India.

Experiments in various Provinces have proved that in famine years cattle can be kept alive on prickly pear, helped by a small ration of hay or other ordinary cattle food.

In Australia, California and other parts of the world, experiments are being made to demonstrate the use, as cattle food, of all Opuntias in general, and of the spineless varieties in particular.

"Experiments conducted in California have shown that by selection and crowning of cactus plants, it is possible to produce a spineless variety valuable as a pasture plant."

Burbank's Spineless Opuntia may prove useful at least as cattle food, in a mixture, if not singly, and may be given a trial in some suitable parts of India.—(S. V. SHEVDE.)

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CULTIVATION OF TREE COTTONS.—Tree cotton is a perennial variety which may occupy the ground for some years.

The method of cultivation should, therefore, approximate more closely to that of fruit orchards than to that of ordinary field crops.

The seedlings should, therefore, be grown from seed sown in threes or fours in well-prepared soil in centres 6 feet more or less apart, or on a well-prepared nursery on a well-drained site. The seed should be sown in this nursery in March at distances of 3 inches, and the plants should be watered. In June-July (beginning of the monsoon) strong young plants will be ready to transplant into their permanent homes. They should be planted out at distances of from 5′ × 5′ to 7′ × 7′ apart according to variety in holes dug to a depth of about 1½ to 2 feet. Care must be taken not to injure the tap-root of the plants in moving them from the nursery. An alternative method which is not costly and which avoids risks in transplanting, is to sow the seed in baskets made of bamboo about 8″ high and 4″ broad, placed close together with the spaces between the baskets filled up with earth. The whole space thus occupied can be watered either by hand or by flow irrigation. The seedlings should be sheltered from hot winds.

When the time for planting has arrived, each seedling can easily be removed from the basket without disturbing the roots to any extent, and to less extent than if grown in earthen pots. Well-rotted cowdung manure should be freely mixed with the soil of the hole in which each plant is permanently planted. The usual showers in India throughout July, August and September should give the plants a good start. An alternative system for trial would be to sow the seed in baskets or in nursery in July and plant out in September.

In land which is liable to be flooded during heavy rains, it is recommended that the seedlings should be planted out on small raised hillocks or on ridges.

This very general advice about tree cotton cultivation is given with diffidence because, except under very favourable conditions, the cultivation of tree cottons on demonstration areas has not been successful in India.

The plantations usually, even in return for expensive cultivation, only give a very small outturn during the first two years, and a very uncertain crop afterwards. It is possible to grow profitably a catch crop (by preference a leguminous crop) between the rows in the first season.

It is advisable that twelve months after sowing, and just before the rains, the trees should be cut down to the lower branches, and pruning should be done each year just before the beginning of the monsoon, so that new branches will bear in the following cold weather. This pruning will check the trees from bearing all the year round, which is an inconvenience, as during the rainy season the cotton bolls are damaged, and besides, the trees should have an annual rest.

After the trees have become established, they require only occasional manuring if the soil is fertile, but the plantations must be kept free of grass weeds and undergrowth.

One chief care is to fight insect pests, to which tree cotton is very susceptible. The pests, when once established, are difficult to get rid of because the trees are perennial.—(EDITOR.)

GOVERNMENT AGRICULTURAL STATIONS.—Mr. D. Clouston, M.A., B.SC., Deputy Director of Agriculture, Central Provinces, in a recent pamphlet, has offered suggestions for the guidance of the managers of Government Agricultural Stations.

The following are his salient points, with a few additions thereon.

On each agricultural station there should be a definite programme of work, the success of which will greatly depend upon an even and otherwise suitable area being selected for each series of experiments.

In making an experiment, its object should be clearly held in view, and the results should only be considered successful when they yield a definite result either positive or negative. It may take years to come to a conclusion.

When a definite result is obtained, the next step is to determine how far it is due to one factor.

The manager of each agricultural station should see that the programme of experiments is carried out with such scientific exactness as will produce reliable results.

The area intended for experimental plots should be carefully standardized by growing an exhaustive Kharif crop suitable to the soil and climate of the locality. If this trial or trials show an uneven area, it should be discarded altogether. In coming to a decision, eye-inspection by an experienced agriculturist during the growing season is probably quite as important as actual weighments at harvest time. Crop pests (particularly white ants) and climatic conditions which are not constant may unequally affect different parts of a selected area. This often happens in India after experiments have been actually started, however carefully the experimental area may have been selected.

Areas which are usually water-logged should not be selected for experiment, but if water-logging only occurs in excessively wet years, the area may possibly be suitable if provided with surface drainage.

The soil of experimental plots should never be levelled down, as such artificial work tends to expose the unweathered subsoil in

parts and bury the weathered surface soil in others. Such treatment excepting in rice beds is fatal to scientific work.

It is desirable, if not necessary, that all the plots of a series the products of which are comparable in a single year, should at intervals of a few years be sown with one kind of crop throughout and thus re-tested for evenness. Moreover, it is important to keep the whole area of the experiment under a rotation (if the issues do not demand different treatment) and in a condition fairly similar to the lands of ryots to which the results of the experiment are likely to be applicable in a practical way.

The size of plots may vary with the nature of the experiment and the kind of crop, but should not usually be less than one-tenth of an acre or more than a quarter acre. For final comparison of outturn of crops before recommending them to ryots, the plots should be at least one acre each.

There should be an equal number of rows in each comparative plot of a particular variety of crop, and very careful regard should be given to the spacing of plants, so that in each plot of a particular variety of crop there should be an equal number of plants. This can easily be arranged in crops like cotton or Jowari. In the case of crops like wheat, gram or linseed, equal distribution of seed should be insisted on, as the exact spacing of plants is not possible.

Vacancies due to defective sowing, germination, or other causes, should be filled in by dibbling or transplanting as soon as they are observed.

In many cases for experimental work the best method of sowing is to dibble in the seed by hand at regular intervals.

Manures should never be placed in heaps on experimental plots, for when rain falls, much of the soluble plant food in such heaps will be very locally distributed or washed into the subsoil, or at least partially lost.

Highly soluble manures should be very equally distributed. Such work requires the very closest supervision of a well-trained native assistant.

The cultural treatment of each plot of an experimental series should be identical as regards preparatory tillage, seed rate, interculture, dates of operations, etc., excepting when variation in any particular is purposely intended.

Usually it will be found convenient to have a non-experimental border round each plot growing the same crop. In harvesting the crop on the actual experimental area, the farm manager can easily exclude that on the non-experimental borders by stretching a line round the edge of the plot and harvesting the non-experimental borders first.

All experimental work not of a purely mechanical nature should be done by, or under the close supervision of, a thoroughly trained Indian assistant.

Seed selection should be similarly done.

Our probationers should be thoroughly taught in such work, and also to demonstrate agricultural methods, machines and implements and be encouraged to improve such by invention.

The manager of a farm or Demonstration area should take special trouble to get cultivators interested in his practical work to visit his place as often as possible, and should be prepared to describe clearly all experiments in progress and demonstrate the advantages of such implements and machines as he can recommend for practical use. He should also explain that his work is intended to improve agricultural practice in India and increase the profits of agriculture by applying science to practice.

The farm manager should be in complete touch with District Agricultural Associations in order that the work on Government Experimental Farms and on Demonstration areas may be brought as fully as possible to the notice of at least advanced cultivators.—(EDITOR.)

* * *

MARSHALL'S 30 H.-P. OIL TRACTOR.—This Oil Tractor is manufactured by Messrs. Marshall, Sons & Co., Ltd., of Gainsborough, England, with the object of supplying a cheap mechanical power for agricultural purposes, which may possibly be useful in India.

The Tractor is fitted with a two-cylinder engine and has three speeds, 2, 4, and 6 miles per hour. The engine can be run on Petrol, Kerosine, Benzine, Gasoline, etc. With tanks filled with kerosine it can be run for ten hours continuously.

The engine is fitted with wide travelling wheels to travel over sandy ground. In working order it weighs approximately $4\frac{1}{2}$ tons and carries 25 gallons of fuel and 75 gallons of water; it is fitted with a water-cooler and a patent pump for circulating water through the cylinder jacket. (Plate XXXII.)

The engine can be used for ploughing, harrowing, cultivating, sowing, reaping and hauling; it can also be used for driving any fixed machinery such as threshing and winnowing machines, corn and cake grinding mills, chaff-cutters, etc., without any addition or alteration. This engine drives 3′ 6″ full size Marshall's Threshing Machine fitted with Chaff fan, Bhoosa rollers and Bhoosa shifters continuously for five hours with a consumption of $1\frac{1}{2}$ gallons of kerosine per hour. One man is required to operate it.

Experiments in India show that it can plough $1\frac{1}{2}$ acres of land that has been previously broken, per hour, with a consumption of less than 2 gallons of "Chester Brand" kerosine oil, and uncultivated land at the rate of one acre per hour with the same consumption of oil.

The cost is Rs. 8,000. The Deputy Director of Agriculture, Bengal, saw the machine at work at Semapore and reported thus:—

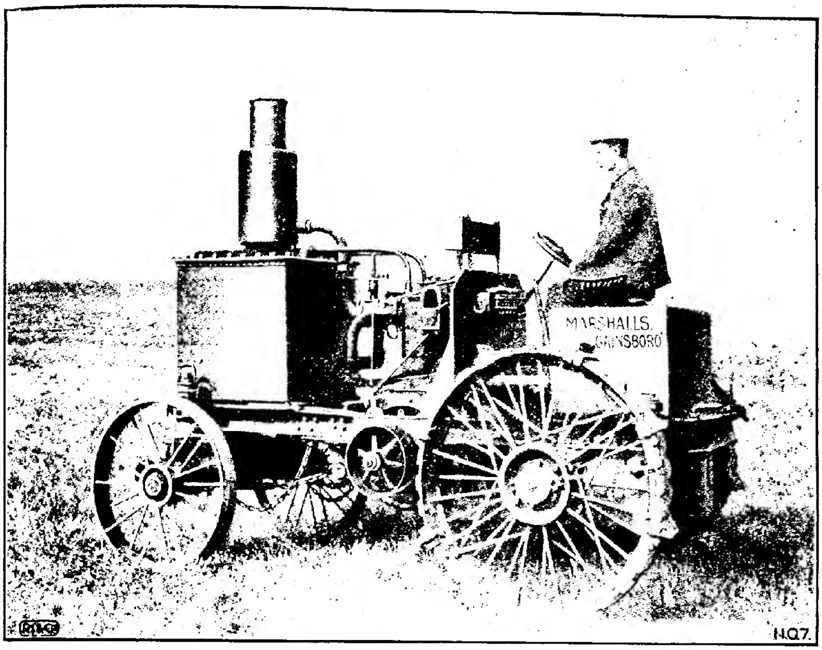
"We were only able to test the ploughing, as there was nothing to thresh and no pumps or ordinary machinery to be worked. Soil tested by ploughing was sandy loam. Two four-furrow ploughs were attached to the back of the Tractor and 8 furrows 6″ deep and $9\frac{1}{2}$″ wide were ploughed at one and the same time.

"Ploughs :—Cockshutt's (Canada) Four Furrow: Plough cost Rs. 300.

Work done—

9 Acres in 7 hours.

PLATE XXXII.



A. J. I.

MARSHALL'S 30 H.P. OIL TRACTOR.

Oil used—

15 gals. Chester Oil.
½ gal. Petrol.
½ gal. Lubricating Oil.

Quality of work done: Excellent.

Fuel:—Cost of working per acre—

	Rs.	A.
Kerosine	8	7
Petrol	0	10
Lubricating Oil	1	12
	10	13 ÷ 9 = Re. 1-3.

Cost of fuel per acre = Re. 1-3 13 acres can be ploughed per day of 10 hours.

Cost of working per day—

	Rs.	A.	
1 Mistri at Rs. 60 per month =	2	0	per day.
2 Coolies " 10 "	0	12	"
	2	12	per day.
Cost of fuel per day (13 acr.)	15	8	
	18	4	per day.

Cost of working by bullocks—

1 Man and pair of bullocks = ½ acre per day.

1 Man ... ... at As.	6
1 Pair of bullocks ... "	6
	12 per day.

To plough 13 acres per day would require 26 ploughs—
26 × 12 = 312, *i.e.*, Cost per day = Rs. 19-8.

Capital Outlay—

	Rs.
Oil Tractor and ploughs	9,000
Bullocks and ploughs	3,000

"Accordingly, without considering initial outlay, where ploughmen can be got at 4 annas and less per day, it is cheaper per unit to plough by means of bullocks.

"The Oil Tractor will not suit small holdings or paddy cultivation, but where large holdings of high land cultivation are concerned and where labour is scarce and dear, the Oil Tractor is an economical motive power for ploughing.

"There is no doubt about the utility of this Oil Tractor. In addition to ploughing, threshing, pumping, sugar-cane crushing and carting, etc., can be done, but in Bengal unless the holding is compact and 200 to 300 acres in extent, high land cultivation is concerned, and ordinary labour costs Re. 1 per head per day, it will be found there is no advantage in changing the ordinary system of cultivation now in vogue in the Province."—(EDITOR.)

REVIEWS.

FIRST REPORT OF THE COMMITTEE OF CONTROL OF THE SOUTH AFRICAN CENTRAL LOCUST BUREAU, PRETORIA, 1907.

IN this report an account is given of the formation of a Central Bureau of the South African Colonies to co-operate against the attacks of locusts in the several colonies, and of its working. Locusts commit extensive damage to crops throughout South Africa, and in Natal particularly measures were adopted against them with success: the value of these measures was largely discounted by the arrival from neighbouring colonies of swarms of flying locusts which replaced those already destroyed and the Government of Natal moved the other colonies to co-operate in the destruction of locusts. This co-operation depends for success upon some efficacious remedy of which one has been introduced in Natal for some years and the action now taken is largely the result of the work of the late Mr. C. B. Simpson, Government Entomologist, Transvaal. The actual formation of the Bureau dates from 1906, a Conference being assembled by the High Commissioner to discuss the project. The Committee of Control of the Bureau consists of one representative, an Entomologist or Locust Officer, from the Cape of Good Hope, Natal, Transvaal, Orange River Colony, Southern Rhodesia, Basutoland, and the Bechuanaland Protectorate. The Governments of German South West Africa and of Portuguese East Africa have since become associated with the Bureau and contribute towards its maintenance.

The Bureau is located in Pretoria and its funds, borne by all the colonies, are administered by the Director of Agriculture of the Transvaal. In each colony, information regarding the

occurrence and location of locusts swarms is collected and sent to the Bureau, usually by special post cards. The Bureau tabulates these and circulates the information. The Bureau also advocated legislation to compel measures being taken against locusts and makes recommendations to the various Governments. The Committee of Control prepare an annual report, of which this is the first. They have a Secretary entirely for their work, who tabulates the reports and distributes Monthly Maps showing where locusts are. When necessary, telegraphic information is also sent.

The first meeting of the Bureau was held in 1907, and it was associated with a meeting of ministerial representatives from the various Governments to consider and lay down a definite policy regarding locust destruction. At this Conference, the action taken in the past was fully discussed and the conference adopted certain resolutions; they emphasised the importance of destroying locusts in the hopper stage; they pointed out that the expenditure incurred was very small in comparison with the value of the crops saved; they endorsed the value of one remedy, using the sweetened solution of arsenite of soda as a poison for the destruction of young locusts.

These recommendations represent the combined experience of many years of the men engaged in locust destruction in South Africa and they are unanimous in adopting a single method of treatment. The remedial treatment universally endorsed is this: that the grass, bushes, etc., which the hoppers are going to eat should be sprayed with a solution of arsenite of soda and sugar or treacle in water, the formula recommended being :—

Arsenite of soda	1 pound.
Sugar or treacle	2 to 4 pounds.
Water	16 gallons.

This solution is highly poisonous but its use is, in South Africa, unattended with any misadventure whatever; fifty tons of arsenite of soda were used in one year with no cases of stock poisoning or poisoning of human beings. The report states definitely that if the solution is properly prepared and applied,

"*it is very difficult for a beast or horse to acquire a noxious dose. Furthermore, fowls, pigs and horses have gorged themselves on the poisoned insects without ill effects.*" The poison is sprayed on with Knapsack sprayers, the hoppers eat the vegetation not only because they are hungry but because the treacle attracts them and they are poisoned wholesale.

The report contains also a chapter on the value of locusts as food and as a commercial product, but its chief interest lies in the fact that the above remedy is practically the only one on which they place any reliance. There are other and less valuable methods, *e.g.*, soap solution, mechanical methods, etc., but they are not fully endorsed. The legislation in force in Natal, recommended for general adoption, provides for the notification of "locust areas," the appointment of locust officers, who may serve notices upon land-owners calling upon them to carry out the destruction of locusts by specific methods, failing which the locust officer does it and recovers the cost from the land-owner. That is, every land-owner must destroy locust hoppers with arsenical solutions or Government does it at his expense: the Government assist by transporting all poisons free by rail, by lending sprayers and by giving warnings of locusts' swarms. In the Orange River Colony, bonuses are given for locusts destroyed, egg-laying and hatching must be notified and hoppers must be destroyed. In Cape Colony, Government gives aid with spraying material and machines: presumably the whole of South Africa will adopt the one remedy and the legislation in each colony will probably be the same.

The locusts of South Africa are distinct from those of India, and the conditions of agriculture naturally determine to a large extent the remedies to be adopted. Neither of the locusts is a desert locust such as is the North West locust of India: they are similar to the Bombay locust save in the important fact that they form swarms in the hopper stage, which the Bombay locust normally does not do. On the other hand, the sudden occurrence of large swarms is partly accounted for by the fact that the eggs do not hatch for years unless rain falls sufficiently; if in a

particular tract sufficient rain falls only after several years, there will be in that tract sufficient eggs accumulated to produce immense swarms and this apparently occurs. This is not known to occur with either of the Indian locusts.

It is perhaps needless to say that the remedy used in South Africa is not applicable to India where the conditions are so wholly different. In planning the Bombay locust campaign in 1903-4, the Natal remedy was kept in view and replaced by others. We have not in India the large stretches of veldt that can be safely poisoned without risk of injury to stock: 36 lbs. of their poisoned fodder will kill a calf, 72 lbs. will kill a bullock: were we to poison crops like this many cattle might die. The Transvaal in one year used 1,500 Knapsack spraying machines: there is not a half of this number in all India. Our two locusts also are totally different, and the administrative system in India is so perfected that the appointment of a vast staff of locust officers is entirely unnecessary even in the biggest outbreaks.

The report emphasises the value of dry locusts both as manure and as food for poultry, the latter specially. There is probably a very good market in India for dried locusts which are already an ingredient in curries, but we question if their value as poultry food is recognised by poultry keepers in India. Detailed directions are given by a poultry keeper as to the ration per fowl, varying from three ounces per week for breeding pens down to half an ounce for young chicks.--(H. M. LEFROY.)

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THE STATUS OF APICULTURE IN THE UNITED STATES. BY E. L. PHILLIPS (BULL. 75, PART VI, U. S. DEPT. OF AGRIC., BUREAU OF ENTOMOLOGY).

IN this bulletin, the author reviews the bee-keeping industry of the United States and the salient facts are of interest as showing to what a pitch of development this industry has been brought in the United States. It is of course impossible to contrast the industry in this country with that in America since there is no regular industry in India, but we may draw conclusions

applicable to this country from the industry as it exists now in the United States.

During the last fifty years the bee-keeping industry in the United States has developed from a small irregular one to an important and highly organised one; the bees used to be kept in box hives; the bar frame hive had not been invented, the methods of getting honey were wasteful and bee-keepers had no control over their stocks. The invention of the movable frame hive by Langstroth in 1851 gave an impetus to the industry and rendered possible the accurate study of the subject, the control of the bees and the gradual development of a large body of expert bee-keepers, with whom the industry is not the principal occupation, but is carried on with other business or in spare time after business is over. It is recognised that in no one place can a bee-keeper profitably work enough hives to give him constant employment but that there is scope for bee-keeping by a large number of persons as a cottage industry occupying only their spare time and it is in this way that the industry has developed naturally. At the same time the author deprecates a large number of very small bee-keepers (with five colonies or less) but advocates developing the industry by Apiarists owning more hives and taking greater care of them, specially as regards disease.

The value of the honey produced annually is put at about six crores of rupees (20,000,000 dollars) and the wax about a tenth of this (sixty lakhs of rupees or 2,000,000 dollars). The industry is thus no small one in its direct value and is a considerable asset in the wealth of the country. Actually about 12 per cent. of farms included bees in their stock in 1899, the value of these bees being put at three crores of rupees (10,000,000 dollars) and the average value per farm of the honey and wax produced is put at thirty rupees for that year.

In spite of this, the total imports of honey to the United States amount to two and half million pounds in 1908, of a value of three lakhs of rupees, and the imports of bees-wax to nearly seven hundred thousand pounds, of a value of five and-a-half

lakhs of rupees. There is, however, an export of honey and wax combined to the value of two lakhs of rupees in the same year.

The above figures give an idea of the magnitude of the industry and show that there is still room for development in the United States; but they show most clearly what a large amount of honey is consumed in the country and this is, to us, the most significant fact. What might not the consumption of honey be in India, where the present consumption of sugar is so large, if the honey were available: and it is to be borne in mind that the honey is there and is simply not available in an edible form, because bee-keeping as an industry is not practised. Apart from the direct value of the domesticated bee as a honey and wax producer, there is its indirect value in the pollenization of flowers. The author states that "the indirect benefit of the bee-keeping industry annually adds to the resources of the country considerably more than the amount received from the sale of honey and wax."

The author also discusses the sources of loss including the loss from swarming, winter losses, waste of wax, enemies, diseases and badly proportioned distribution of apiaries. When apiculture comes to be developed in India, these sources of loss will be worth considering: for the present we may point out that the very considerable winter losses would not, as a rule, occur in India, though others might. The author then discusses the needs of the industry, classing them as Scientific, Economic and Educational. All of these are likely to be met, the first by an extension of scientific investigation, the second by the general adoption of better methods by bee-keepers, the third by the action of the Bureau of Entomology in getting into touch with bee-keepers and *educating the public in the use of honey*. There would then be increased production and also increased use of honey as food by the people.

One salient fact the author emphasises is that what is wanted is the expert bee-keeper who is financially interested, who keeps a good number of colonies and who takes the work seriously, not necessarily as his main business but as an important

side-line. The small bee-keeper little interested in the subject, who keeps a few colonies badly, in the hope of getting a small yield but not a large profit, is a danger to the community because his hives are a source of disease infection. "Do it well or not at all" is the principle he insists on, that should guide the development of the industry.

The figures given above are worth consideration as regards this country. Honey as an article of food is limited to the hill forest areas of India, where wild honey is collected or where bees are kept in a state of semi-domestication in hollow logs or earthenware pots. As an article of general consumption it is almost unknown, though there are throughout India abundant wild bees which collect honey, and in some instances store large quantities of it. It is open to question whether pollenization is not already effected by such wild bees and whether on this ground the introduction of bee-keeping would have the same importance it has in the United States. But there can be no question that a valuable industry is being neglected, that there would be a very large consumption of honey were it available and that one of India's assets is wasted.

India is where America was sixty years ago; could India be in sixty years where America is now? Possibly, but certainly not until the value of bee-keeping is recognised and the industry is developed.—(H. M. LEFROY.)

SUGAR-CANE TREATED FROM THE MANURIAL POINT OF VIEW BY JOHN KENNY, DIRECTOR OF AGRICULTURE, JUNAGHAD STATE. (HIGGINBOTHAM & CO., MADRAS, 1909.)

MR. JOHN KENNY, Director of Agriculture, Junaghad State, has just published a pamphlet entitled "the sugar-cane treated from the manurial point of view."

After noticing the fact that five-eighths of the world's supply of sugar comes from the sugar-beet, which it might be possible to grow under suitable conditions in North India (Dr. Leather), the author points out that while the price of

sugar has declined, the cost of production by the old methods has remained the same.

In view of the present state of the indigo industry, sugar-cane is attracting the attention more and more of planters in Bengal and for this reason the paper under review may be of interest. Mr. Mollison and others have said that experiments at Government Farms have showed that sugar-cane might be produced more economically in India than in any other country in the world.

With reference to cattle manure, Mr. Kenny says: "Large quantities of it will contain a certain amount of salt which improves the growth of the cane wonderfully, but reduces the quantity of sugar contained in the juice. The Poona district growers should bear this in mind. Unfortunately for them the Government experiments have shown splendid growths of juicy cane by the use of enormous quantity of cowdung and poudrette, which was a waste of nitrogenous manure and certainly did not produce much sugar." To the latter part of this statement about the quantity of sugar produce, exception may be taken. In the Report on the Manjri experiments carried out from 1894 to 1903 we find that Farm Yard manure produced up to 11,000lbs. raw sugar per acre and poudrette produced even more, namely, 10,000 to 13,000lbs. per acre: surely, these amounts are up to the best yields of sugar obtained by most sugar-producing countries. If, however, Mr. Kenny means the quality of the juice produced is not good, in answer to this we may turn to an article on manuring sugar-cane by Dr. Leather which appears in the *Agricultural Journal of India*, Vol. I, Part 1. There we find on page 22 the statement that "In the Manjri experiments it appears probable that the largest amounts of manure used were unnecessarily large, probably half as much again as was necessary to produce the heaviest crops. But the cane did not suffer, the crops grew to great perfection and the *gur* was excellent." A case did occur in which an excessive amount of manure improved the quality of the juice, but Dr. Leather says of it, "it is an extreme case and naturally must not be taken to indicate that sugar-cane should not be liberally manured."

With reference to the application of the large dressings of organic manures given in experiments in India, Mr. Kenny says the result is not only a great waste of Nitrogen but an accumulation of salts which the sugar-cane, gross feeder that it is, takes up with the other plant-foods. The presence of these salts results in a watery juice, deficient in crystallizable matter. He also adds that the presence of reh or other salts in the soil has the same effect.

We find it stated that green manures are used in many parts of India, and it is recommended that phosphoric acid and potash manures be applied to the green manure crop.

Mr. Kenny states that no mention of trials with potash is made in the Government reports. However, in the Annual Report of the Department of Agriculture, Bombay, for 1907-8 we find the following: "Sulphate of ammonia seems to do better when added alone to cake and Farm Yard manure than when *potash* is also added. *Sulphate of potash was found to have no value* when applied with such heavy dressings of cake and Farm Yard manure." Also in the programme of work for 1908-9 of the Manjri sugar-cane experiment station we find provision is made for experiments with potash manures.

The following table taken from the pamphlet shows what a gross feeder the sugar-cane is. It gives the amount of plant-food in lbs. per acre removed by various crops.

Plant.	Nitrogen.	P_2O_5.	K_2O.	CaO.
Sugar-cane ...	127	44	298	71
Wheat ...	43	33	36	16
Barley	47	23	54	11
Maize	61	31	66	14
Rice	41	26	68	10
Potatoes	26	13	48	2
Cotton	54	19	40	25

Thus sugar-cane easily heads the list and it is especially noticeable how much more potash it removes than any other crop. Mr. Kenny adds if as should be the case the tops, leaves and thrashing of the canes and skimming and residues of the sugar house be returned to the soil, then the above figures for cane will be reduced considerably.

Manurial experiments in Java and Honolulu are quoted. In the former it is concluded that earthnut cakes give an immense return, but the juice is very poor, whilst small quantities of bone acid phosphates and potash show a very high return of sugar.

The Honolulu experiments show the most profitable combination of manures to be nitrogen plus potash which produced an increase of 9,922 lbs. sugar per acre over the unfertilised plot.

Experiments are quoted showing the great value of phosphoric acid and potash in Louisiana, Leeward Isles, Java and Hawaii.

Mr. Kenny states that the 'gul' obtained from the bone manure plots at Manjri was best of all, golden yellow in colour, with sparking crystals and firm as could be desired. It kept dry in the monsoon when 'gul' made from cane fertilised with poudrette and oil-cake manures generally gets pasty from the damp.

Mr. Kenny raises an interesting point when he mentions that in Hawaii as a question of economy it is proposed to apply all soluble fertilisers such as nitrate of soda in the irrigation waters.

He next devotes some pages to the manuring of sugar-cane in Egypt and discusses the effect of nitrogenous, phosphatic and potassic manures on the plant. Here we find recommended certain manures for cane in Egypt and the time and mode of application is stated.

On pages 27 and 28 Mr. Kenny hints at good results obtained by cultivators in India from the use of concentrated fertilisers, but he omits to mention what the fertilisers were.

Mr. Kenny quotes on page 29 a very interesting table of manurial experiments carried out at Poona under Prof. Knight. He says this table shows clearly the excellent results obtained from artificial fertilisers in a district where heavy manuring is ordinarily resorted to with good cattle manure. How are we to reconcile this with his former statement on page 5, among other scathing ones, about trials made by officials in the Bombay Agricultural Department that "as to potash we find no mention of it,

in the Government Reports." In any case this is the first time that this fine series of experiments has been classed as "ridiculous." After mentioning the destruction caused by the borer moth, the author goes on to say that it is admitted by all sugar-cane planters that continued propagation from cuttings grown year after year in the same soil results in a serious degeneration.

As an explanation of the cause of disease which is produced when cane is grown continuously on the same land Mr. Kenny offers the theory which is coming to the fore lately that plants excrete from their roots substances which are detrimental to their own growth.

The whole object of the pamphlet seems to be to show that potash does not seem to have been given a fair trial in India. Since the function of potash in plants is to aid in building up carbohydrates such as sugar, starch, etc., it seems only reasonable to suppose that it will be of great benefit as a manure for sugar-cane.—(H. E. ANNETT.)

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A NOTE ON THE MANUFACTURE OF PURE SHELLAC, BY PURAN SINGH, F.C.S., ACTING FOREST CHEMIST. INDIAN FOREST MEMOIRS I. PART II, PP. 1—20.

IN this Memoir the author discusses a method of preparing pure shellac from the ordinary stick-lac produced in India. Lac. in whatever form, is valued by the trade precisely according to its colour: the lighter the colour, the more valuable the lac. This colour is dependent upon two things, the inherent colour of the lac-resin and the purity of the finished lac as regards the dye. The author fails to recognise this and attributes the whole question of price to the degree of absence of dye. Apart from this, the author is right in laying stress on the freedom of the lac from dye; it was apparently believed that lac from which the young had swarmed would contain no dye; anyone with practical knowledge of lac would know this is not so, and Phoongi Lac, or lac from which the young have swarmed, requires washing to free it from dye, just as any other lac does. It however contains

less dye. The Forest Department having proved this by chemical analysis, the author was led to try to obtain shellac, from Phoongi or other lacs, free of dye. This is done at present by washing and, though the author does not appear to know it, by the ordinary process of washing as practised in India, shellac can be obtained which is practically free of dye and it is constantly so obtained. Believing that lac cannot be freed of its dye by ordinary means and neglecting the inherent differences in colour of the various lacs, the author was led to believe that the pure lac-resins could be extracted by means of methyl-alcohol. He gives a description of various lacs, their chemical analyses, and describes the present methods of lac-refining and manufacture. He touches on the early methods tried for improving the manufacture of shellac but is not clear as to why they failed.

The author then discusses the waste in the present method of manufacture and his view that there is a large waste of irrecoverable resin during manufacture is one that should be impressed on every manufacturer of shellac. There is a great waste, and in these days, any saving in manufacture must be closely attended to. He then discusses the important question of the extraction of the resin by means of wood-spirit. Methyl-alcohol, which forms the bulk of wood-spirit, has the property of dissolving the lac-resins but not the dye; ethyl-alcohol dissolves the resins but also part of the dye. If the crude lac is then treated with wood-spirit, a solution of the valuable pure lac-resins should be obtained free of dye. Primarily the author has used this in the laboratory for the estimation of lac-resin and dye, but he believes that it can be applied in practice. He suggests that the lac be finely pulverised, after thorough drying, that the powder be exposed to the action of methyl-alcohol and that the solution of resin so formed be evaporated till pure shellac is left. He describes an apparatus in which he thinks that this operation can be carried on without waste of wood-spirit, the spirit from the evaporated solution being passed into the lac receptacle, condensed and used again to dissolve the resin. While giving many reasons why the process should be good, the author is

unable to say that it is practicable or how it is actually working out. How much wood-spirit is lost? What is the actual cost of producing shellac? Is it really possible to stretch the sheets of shellac and how are the sheets actually obtained? In practice we have found it extremely difficult to know when to stop the heating of the solution of shellac in spirit, *i.e.*, when it has really lost all its spirit and will set: how then is it to be obtained in sheets and stretched? We could mention many more practical difficulties, and it is a matter of regret that the process is as yet a purely theoretical laboratory one without practical application: the attention of the shellac trade has been drawn to this process: the trade is, at present, extremely depressed and any process of practical value might be of immense importance: it is to be hoped that the author will pursue his researches on a really practical scale and by showing the cost of producing shellac by this means enable the manufacturer to judge how far he can adopt it and whether he can really reduce the cost of separating the pure lac-resin from the crude lac. Even then, we doubt if the author is justified in talking about our being "enabled to meet the growing demand for shellac outside India." The present is a period of low prices, lower than for more than ten years and this because there is *not* an increasing demand. To the lac-grower as to the shellac-refiner, the times are hard and a cheap process will be of value: but a very great deal of practical work must be done before the proposed method can be anything more than a theoretical laboratory method, and if the author is desirous of benefiting the lac industry, he will carry on the work to the point of practical utility.—(H. M. Lefroy.)

* * *

The Year Book of the Department of Agriculture, U. S. A., and the Annual Report of the Office of Experiment Stations, 1907.

These two volumes, just received, make interesting reading. The Secretary's report in the Year Book, extending to 138 pages, is a comprehensive review of the year's work. In spite of

unfavourable weather conditions, the year has been one of unequalled agricultural prosperity, the smaller crop yields being more than counterbalanced by their greater money value.

In Vol. III, Part I of the *Agricultural Journal of India* a rather full account was given of the activities of the Department and it is unnecessary to enlarge on these again. The work of the Department continues to expand at a great pace. The grant for Agriculture in 1907 amounted to \$ 10,118,451 (\$ 1 = Rs. 3 approximately) which was increased to \$ 12,210,156 for 1908. The number of people employed by the Department in 1907 was close on nine thousand, but it is necessary to remember that the U. S. Department of Agriculture includes the Forest service, the Bureau of Animal Industry, the Weather Bureau, the Bureau of Biological Survey and the Office of Public Roads. There were 64 Agricultural Colleges or institutions at which courses in Agriculture were given, and about 60 principal Experiment Stations.

The order of importance of the chief crops was maize, hay, cotton, wheat, oats, potatoes, barley, tobacco, sugar (including cane and beet), linseed, rye, rice, buckwheat, and hops. There is continuous effort to improve existing varieties by selection and by hybridisation, and at the same time the whole world is being explored for new crops and new varieties to suit the diversified conditions of the various States of the Union. The degree to which the maize crop has been improved in America for yield and quality of grain and for forage is well known. Early varieties of cotton are being produced in the South to escape the ravages of boll weevil. A practical apparatus has been devised for getting rid of light cotton seed, and it is claimed that the yield is thus raised 10 to 15 per cent. Wilt-resistant melons have been produced and attempts are being made to breed a rust-resistant asparagus. These are but examples of the work that is being done on all the principal crops. Among recent introductions of new crops or varieties, perhaps durum wheat has been most successful. First brought from Europe in 1899, the crop in 1907 was worth \$ 30,000,000. Mangoes imported from India within the last

few years are becoming very popular and the mango industry promises to be a big one. The beet sugar industry is another in which there has been phenomenal expansion, having increased from 6,000 tons in 1891 to 50,000 tons in 1907. Drought resistant alfalfas (varieties of Lucerne) and dry land rices recently discovered in China are expected to do well. A new variety of Soy bean has been discovered in the same country suitable for rotating with rice.

The Adams Act passed in 1906 promises to put the work at the Experiment Stations on a much higher plane than heretofore. The funds provided by this Act are only available for fundamental investigations, and nearly all the Stations have shown themselves only too anxious to undertake such work—in fact, a much larger number of investigations has been proposed than it will be possible to carry out satisfactorily. The great difficulty is the lack of sufficient men with the necessary scientific equipment and training for research. The Office of Experiment Stations occupies a very important position in advising on and co-ordinating the various projects. The discussion incident on the preparation of these projects has not only made clear the kind of work which can properly be undertaken under the Act, but has had the indirect effect of systematising the Station work generally.—(E. SHEARER.)

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